MOTOROLA

Service Manual
Level 3
Release 1

TALKABOUT™

DIGITAL WIRELESS TELEPHONE

TDMA T2290/T2297

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About This Manual

Scope of Manual

This manual is intended for use by experienced technicians familiar with similar types of equipment. It is intended primarily to support basic servicing, which consists primarily of mechanical repairs and circuit board replacement.
Authorized distributors may opt to receive additional training to become authorized to perform limited component repairs. Contact your regional Customer Support Manager for details.

Model and Kit Identification

Motorola products are specifically identified by an overall model number on the FCC label. In most cases, assemblies and kits which make up the equipment also have kit model numbers stamped on them.

Service

Motorola regional Cellular Subscriber Support Centers offer some of the Þnest repair capabilities available to Motorola Subscriber equipment users. The Cellular Subscriber Support Centers are able to perform computerized adjustments and repair most defective transceivers and boards. Contact your regional Customer Support Manager for more information about Motorola's repair capabilities and policy for in-warranty and out-of-warranty repairs in your region.

General Safety Information

Portable Operation

DO NOT hold the radio so that the antenna is very close to, or touching, exposed parts of the body, especially the face or eyes, while transmitting. The radio will perform best if it is held in the same manner as you would hold a telephone handset, with the antenna angled up and over your shoulder. Speak directly into the mouthpiece.
DO NOT operate the telephone in an airplane.
DO NOT allow children to play with any radio equipment containing a transmitter.

Mobile Operation (Vehicle Adaptor)

As with other mobile radio transmitting equipment, users are advised that for satisfactory operation of the equipment and for the safety of personnel, it is recommended that no part of the human body shall be allowed to come within 20 centimeters of the antenna during operation of the equipment.
DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere. Mobile telephones are under certain conditions capable of interfering with blasting operations. When in the vicinity of construction work, look for and observe signs cautioning against mobile radio transmission. If transmission is prohibited, the cellu-

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lar telephone **must be turned off** to prevent any transmission. *In standby mode,* the mobile telephone will automatically transmit to acknowledge a call if it is not turned off.
All equipment must be properly grounded according to installation instructions for safe operation.

Portable/Mobile Telephone Use and Driving

Safety is every driver's business. The portable telephone should only be used in situations in which the driver considers it safe to do so. Use of a cellular portable while driving may be *illegal* in some areas.
Refer to the appropriate section of the product service manual for additional pertinent safety information.

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Specifications

Table 1.Overall System

Function	*Specification*
Frequency Range	**TX (800MHz)** : 824.04 - 848.97 MHz Channels 1 to 799, f_{TX} = 0.03 * N+ 825MHz Channels 990 to 1023, f_{TX} = 0.03(N-1023)+ 825MHz **RX(800 MHz)**: 869.04 – 893.97 MHz Channels 1 to 799, f_{RX} = 0.03 * N+ 870MHz Channels 990 to 1023, f_{RX} = 0.03(N-1023)+ 870MHz **TX (1.9 GHz)** : 1850.01 – 1909.95 MHz Channels 1 to 1999 f_{TX} = 0.03 * N+ 1849.98MHz **RX (1.9 GHz)** : 1930.05 – 1989.99 MHz Channels 1 to 1999 f_{RX} = TX + 80.04MHz
Channel Spacing	30 kHz
Channels	832 (800MHz), 1999 (1.9 GHz)
Duplex Spacing	45 MHz (800MHz), 80.04 MHz (1.9GHz)
Input/Output Impedance	50 ohms (nominal)
Operating Voltage	+3.6 to +4.1Vdc
Dimensions	120cc (Volume)
Weight	140 g
Display	96 X 32 Graphic Matrix
Analog RF Power Output	0.316 Watts (25 dBm)
Digital RF Power Output	0.562 Watts (27.5 dBm)
Automatic Power Control	9, 4 dBm steps

Table 2. EAMPS System

Function	*Specification*
Modulation Type	FM
Frequency Stability	$\pm$ 2.5ppm
Duty Cycle	Continuous
Audio Distortion (transmit and receive)	Less than 5% at 1 kHz; $\pm$ 8 kHz deviation
FM Hum and Noise (C-MSG weighted)	32 dB below $\pm$ 8 kHz deviation @ 1 kHz
Voice Modulation	Maximum $\pm$ 12 kHz deviation
Transmit Audio Sensitivity	9 kHz deviation (nom.) @ 97 dB SPL input @ 1 kHz
Receive Sensitivity	-116 dBm for 12 dB SINAD (C-MSG weighted)
Adjacent and Alternate Channel Desensitization	-16 dB @ +30 kHz, -60 dB @ $\pm$ 60 kHz
IM	Greater than 65 dB

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Table 3. DAMPS System

Function	*Specification*
Modulation Type	π/4DQPSK
Frequency Stability	± 200 Hz
Duty Cycle	32.3%
Error Vector Magnitude (π/4DQPSK mode)	Error Vector Magnitude [Digital] 12.5%
Transmit Audio Sensitivity	TOLR of –46 dB nominal
Receive Sensitivity	-116 dBm for 3% static BER
Adjacent and Alternate Channel Desensitization	-116 dBm for 3% static BER
IM	Less than or equal to 3% static BER

Table 4. Environment

Function	*Specification*
Temperature	-30ºC to +60ºC
Humidity	80% RH at 50ºC
Vibration	EIA PN1376
Shock	EIA PN1376

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Cellular Overview

Introduction

A cellular mobile telephone system divides the service area into small, low power radio frequency coverage areas called cells. A cellular system consists of a more or less continuous pattern of these cells, each having a 1 to 40 mile radius (typically 5 - 10 miles). Within each cell is a centralized cell site with an elevated antenna and a building. The building houses a base station with transceivers and related control equipment for the channels assigned to that cell. All the cell sites within a system are then connected either by dedicated land lines, microwave links, or a combination of both to a central control site called the central controller or switch .

The switch controls the entire cellular system and serves as the interface between the cellular telephone user and the landline network. Each cell site operates on an assigned access channel, and may have any number of paging and voice channels assigned to it.

Figure 1. Channel Assignments

A BAND	CHANNELS
Primary Control Channels (21):	313 - 333
Secondary Control Channels (21):	688 - 708
Voice Channels...	001 - 312,
(395 AMPS / 1185 NAMPS):	667 - 716, and 991 - 1023

B BAND	CHANNELS
Primary Control Channels (21):	334 - 354
Secondary Control Channels (21):	737 - 757
Voice Channels...	355 - 666 and
(395 AMPS / 1185 NAMPS):	717 - 799

NOTE:
In NAMPS applications, each AMPS voice channel provides space for three NAMPS voice channels. Digital cellular multiplexes voice channels to allow for the possibility of several additional conversations on a single channel.

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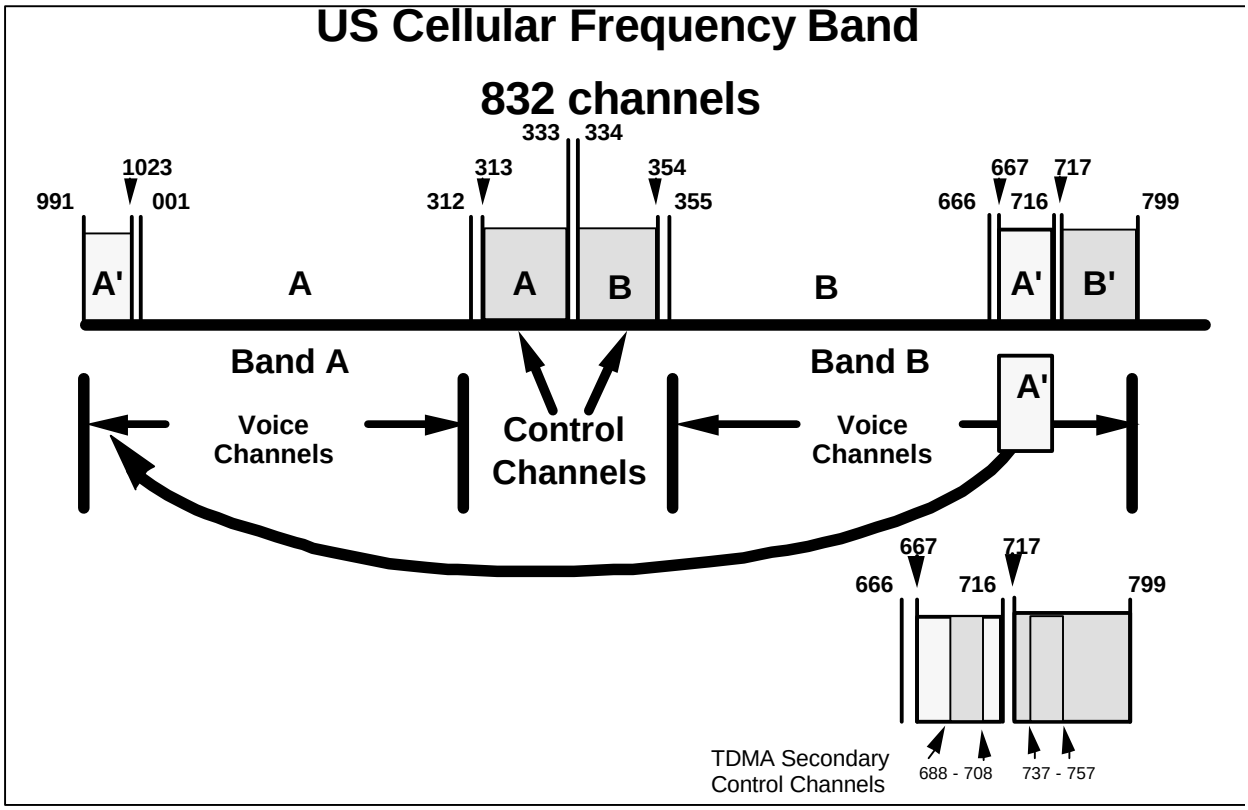
The cellular radio frequency spectrum has been divided by the FCC into two equal segments or bands to allow two independent cellular carriers to coexist and compete in the same geographic coverage area. Each band occupies one half of the available channels in the cellular spectrum. Initially there were 666 channels available across the entire cellular spectrum, but that number was expanded to 832 channels in 1987, and with NAMPS to 2,412 channels in 1991. Digital cellular promises to make a further expansion. To guarantee nationwide compatibility, the signaling channel frequencies have been pre-assigned to each segment (band). The two bands and their assigned channels are defined in Figure 1.

Originally the B Band was assigned to the telephone company (referred to by a euphemism, the Wireline carrier). The A Band, by default, was referred to as the Non-Wireline carrier, guaranteed competition to the telephone company. Today the terms Wireline and Non-Wireline have little meaning since telephone company carriers now operate A Band systems, and vice-versa.

Control (Data) Channels

A cellular telephone in the cellular system is under the indirect control of the switch, or central controller. The central controller uses dedicated control channels to provide the sig-

Figure 2. US Cellular Frequency Band



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naling required to establish a telephone call. Control channels are used to send and receive only digital data between the base station and the cellular telephone. Voice channels are used for both audio and signaling once a call is established. The 21 control channels in each band may be dedicated according to two different applications: access and paging channels.

The data on the forward control channel generally provides some basic information about the particular cellular system, such as the system ID and the range of channels to scan to find the access and paging channels. Access channels are used to respond to a page or originate a call. The system and the cellular telephone will use access channels where two-way data transfer occurs to determine the initial voice channel. Paging channels, if used, are the normal holding place for the idle cellular telephone. When a call is received at the central controller for a cellular telephone, the paging signaling will occur on a paging channel. In many systems both control channel functions will be served by the same control (access) channel for a particular cell. Only in very high density areas will multiple control (paging) channels be required.

Primary control channels are used by all types of telephones. Secondary control channels are only used by TDMA telephones, providing them with an improved probability of locking onto a TDMA control channel.

Voice Channels

Voice channels are primarily used for conversation, with signaling being employed as necessary to handle cell-to-cell hand-offs, output power control of the cellular radiotelephone, and special local control features. Data from the cell site (known as FORWARD DATA) and data from the mobile or portable (known as REVERSE DATA) is sent using frequency shift keying. In AMPS signaling, various control and response tones are used for a variety of applications to be described later. However, in NAMPS signaling, the signaling data and tones have been replaced by sub-audible digital equivalents that constantly ride underneath the audio. And, of course, in digital cellular, all signaling is digital.

Signaling Protocol

In 1983, when the Federal Communications Commission (the FCC) licensed cellular telephony, the signaling protocol used was AMPS. AMPS (Advanced Mobile Phone Service) was the invention of Bell Labs, the signaling protocol that was ultimately adopted by all the governments of the entire Western Hemisphere and, eventually, several other governments throughout the world.

Today, with the implementation of Narrow AMPS and TDMA, and the imminence of CDMA, it may seem that AMPS is out of date. The truth is that AMPS is very much alive, at the very core of all these traffic expanding alternatives to the original signaling protocol developed for conventional cellular telephony.

Under the original AMPS protocol there were 21 control channels assigned to each of two possible carriers in any metropolitan area, with a total of 333 channels assigned to each carrier. Prior to 1987 the FCC had allocated 312 channels to voice (voice, DTMF, or data)

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applications for each carrier. In 1987 the FCC expanded the cellular spectrum (Expanded Spectrum) from a total of 666 channels to 832 channels, allowing for an increase of 83 voice channels for each carrier. But the number of control channels remained constant, *21 control channels for each carrier*.

In 1991, responding to the demand for even more voice channels, Motorola introduced NAMPS (Narrow AMPS), expanding the voice channels by a factor of 3, assuming all subscribers are using NAMPS telephones. But one thing remained constant, there were *21 control channels for each carrier*.

In 1992, when Motorola tested its TDMA digital product, digitizing three communication links on each of 395 voice channels, one thing remained constant: there were still *21 control channels for each carrier*.

Leaving the control channels more or less untouched is the key to allowing telephones that are not capable of NAMPS or digital operation to have access to the system using the conventional AMPS scheme. In virtually every scheme (AMPS, NAMPS, or digital), each control channel has a bandwidth of 30 kHz and uses the signaling protocol, with minor variations for NAMPS and digital, developed for conventional AMPS

The primary difference between NAMPS and AMPS is that a NAMPS voice channel has a bandwidth of only 10 kHz, whereas an AMPS voice channel has a bandwidth of 30 kHz. In addition, NAMPS does not make use of certain control and response tones on voice channels as does AMPS, but uses digital equivalents instead.
As the name implies, the primary difference between digital cellular and AMPS is that all signals are digitized, including voice.

At a basic level, cellular telephony has two divisions: analog cellular and digital cellular. In the following section, analog cellular (AMPS and NAMPS) will be discussed. In the succeeding section, digital cellular will be treated.

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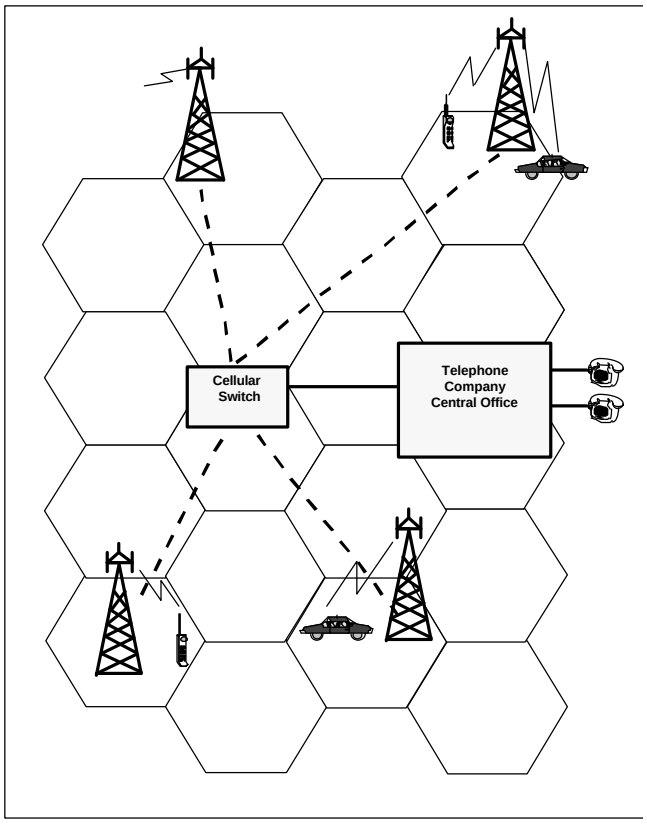
Analog Cellular

The simplified block diagram on page 1 - 7 illustrates an imaginary layout of one side (Band A, or Band B) of a hypothetical service area. The hexagons represent cells, and some of the cell sites shown here also illustrate the fact that an antenna tower and set of base stations are associated with each site. In a real world environment individual cells do not have the hexagonal shape but may take any form as dictated by the environment.

The cell sites are in communication with individual portable and mobile cellular telephones. These portables and mobiles may move from cell to cell, and as they do they are "handed off" under the supervision of the central controller (switch).

Figure 3. Channel Assignments



As illustrated(figure 3.) by the antenna tower on the upper left, cell sites transmit overhead messages more or less continuously even if there are no mobiles or portables active within that cell.

The switch (center left) is in control of the system and interfaces with the central office of the telephone company. As illustrated by the deskset telephones, the telephone company interfaces with the entire landline network.

The cell sites and the mobiles and portables communicate through the use of data or, in the case of AMPS, through the use of data and tones. A complete analysis of data signaling is beyond the scope of this manual. Refer to the Electronic Industries Association standard EIA-553 for a thorough discussion of AMPS signaling protocol, or to Motorola's NAMPS Air Interface Specification for NAMPS.

The tones used in AMPS signaling are Signaling Tones and Supervisory Audio Tones. NAMPS uses sub-audible digital equivalents.

Signaling Tone (ST) and Digital ST (DST)

In AMPS, signaling tone is a 10 kHz signal used by the mobile or portable on the reverse voice channel (REVC) to signal certain activities or acknowledge various commands from the cell site, including hand-offs, alert orders, and call terminations, and to indicate switch-hook operation. Various burst lengths are used for different ST activities. On NAMPS channels ST is replaced by a digital equivalent called Digital ST (DST) which is

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the complement of the assigned DSAT.

SAT (Supervisory Audio Tone) and DSAT (Digital SAT)

The Supervisory Audio Tone (SAT) is one of three frequencies around 6 kHz used in AMPS signaling. On NAMPS channels SAT is replaced by one of seven sub-audible digital equivalents or vectors called DSAT. SAT (or DSAT) is generated by the cell site, checked for frequency or accuracy by the cellular telephone, then transponded (that is, not merely reflected but generated and returned) to the cell site on the reverse voice channel (REVC). The cellular telephone uses (D)SAT to verify that it is tuned to the correct channel after a new voice channel assignment. When the central controller (switch) signals the mobile regarding the new voice channel, it also informs the mobile of the SAT frequency or DSAT vector to expect on the new channel. The returned (D)SAT is used at the cell site to verify the presence of the telephone's signal on the designated channel.

In general there are three uses of (D)SAT: (a) it provides a form of squelch; (b) it provides for call continuation (but if equipped for it, the switch will allow for VOX on all models); and (c) (D)SAT is used to prevent co-channel interference.

DTMF (Dual Tone Multi-Frequency)

DTMF (Dual Tone Multi-Frequency) touch-code dialing may also occur on voice channels. DTMF selects two tones from a total of nine (cellular only uses seven of these tones / four low and three high tones) to uniquely represent individual keys.

Figure 4. Channel Assignments

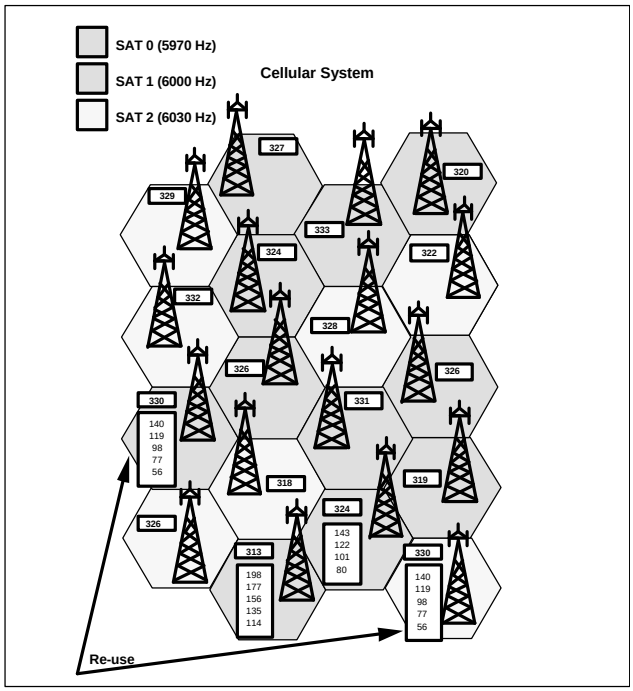

Table 5. DTMF Values

Key	Low Tone	High Tone
1	697	1209
2	697	1336
3	697	1477
4	770	1209
5	770	1336
6	770	1477
7	852	1209
8	852	1336
9	852	1477
*	941	1209
0	941	1336
#	941	1477

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Analog Cellular Signal Summary (AMPS and NAMPS)

The diagrams on the following pages outline the various uses of the signals employed in cellular systems. These signals include: SAT (Supervisory Audio Tone) 5970 Hz, 6000 Hz, or 6030 Hz. Used in AMPS for channel reuse, muting audio (squelch), and call continuation [typically ± 2 kHz deviation]. Digital SAT (DSAT) - One of seven codes or vectors used in NAMPS for the same purpose as SAT [± 700 Hz sub-audible NRZ data].

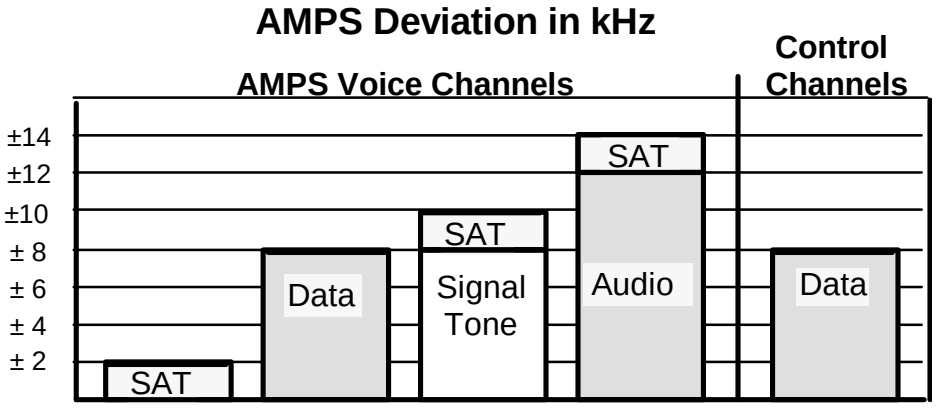
Data - Transmitted at 10 kilobits/second in AMPS and 200 bits/second in NAMPS. Data is used for sending System Orders and Mobile Identification. Do not confuse data with the 10 kHz signaling tone. In AMPS, data is transmitted as Manchester-encoded Frequency Shift Keying (FSK), where the carrier is shifted high or low 8 kHz, and the trailing edge transition is used to represent the logic. In NAMPS, data is transmitted as NRZ (Non-Return to Zero) FSK, where the carrier is shifted high or low 700 Hz, and the frequency shift itself is used to represent the logic.

Signaling Tone (ST) - A 10 kHz tone used in AMPS for mobile ringing, call terminations, hand-offs, and switch-hook operation [typically ± 8 kHz deviation]. ST is always accompanied by SAT.

Digital ST (DST) - One of seven digital equivalents of ST used on NAMPS channels. The transmitted DST is always the complement of the assigned DSAT [± 700 Hz sub-audible NRZ data].

Audio - Includes microphone audio and DTMF [maximum ± 12 kHz deviation AMPS, ± 5 kHz deviation NAMPS]. DTMF deviation should be measured on the radians scale; use key five looking for 9 radians. Audio is accompanied by SAT in AMPS signaling.

Figure 5. AMPS Deviation in kHz



Total deviation of two or more signals is cumulative.

Going into Service

When first turned on, the cellular telephone will scan through the nationwide set of forward control channels (FOCC's) and measure the signal strength on each one. It will then tune to the strongest one and attempt to decode the overhead control message. From the overhead message, the telephone will be able to determine whether or not it is in its home system, and the range of channels to scan for paging and access. Telephones not in their home system will be able to use other cellular telephone systems depending on the level of service requested by the user. If paging channels are used, the telephone next scans each paging channel in the specified range and tunes to the strongest one. On that channel the telephone continuously receives the overhead message information plus paging messages. At this point the telephone idles, continuously updating the overhead message information in its memory and monitoring the paging messages for its telephone number.

Step 1. The telephone powers up and runs a self-test. The NoSvc indicator is illuminated.

Step 2. The telephone scans its preferred system (A or B) as selected in programming.

Step 3. The telephone scans all twenty-one control channels.

Step 4. The telephone tunes to the strongest control channel.

Step 5. Decision point. Can the overhead message from the strongest control channel be decoded? If not, go to step 6. If it can be decoded go to step 8.*

Step 6. The telephone tunes to the second strongest channel.

Step 7. Decision point. Can the overhead message stream be decoded? If not, go to step 12. If it can be decoded, go to step 8.*

Step 8. Decision point. Does the decoded System ID match the Home System ID programmed in the telephone? If not, go to step 9. If it does match, go to step 10.

Step 9. The telephone turns on the ROAM indicator.

Step 10. The telephone turns off the NoSvc indicator.

Step 11. The telephone idles. Typically a rescan occurs after 5 minutes.

Step 12. The telephone turns on (or leaves on) its NoSvc indicator.

Step 13. The telephone switches to the non-preferred system as recorded in programming, and goes back to step 3. The ability to return to step 3 can be disabled by some settings of System Registration.

*The area between Decision point 5 and Decision point 8 can be quite active.
In a few larger systems, following the suc-

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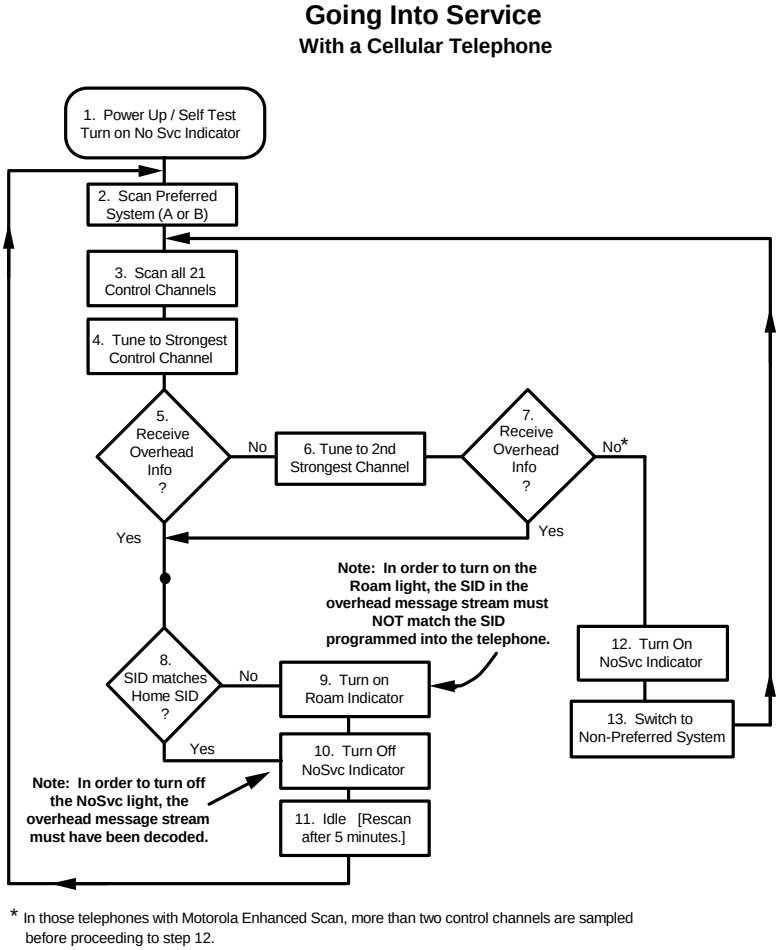
cessful completion of either steps 5 or 7, the telephone scans a set of paging channels, tunes to the strongest, and attempts to decode the overhead message train. The procedure is exactly equivalent to that followed for the access (control) channel. Also at this point, in a few larger systems, the telephone is commanded to identity itself (transmit) and thereby indicate its location in the system. This is called Autonomous System Registration and, like paging channels, is used to improve paging efficiency.

If the system employs Narrow AMPS, part of the overhead message stream is used to ask the for activity on one of the secondary or "digital" control channels, whereas a CDMA telephone will look for pilot signals. If digital signaling is not present, and if the telephone is capable of dual mode operation, it will default to AMPS mode.

Figure 6. Going into Serivce

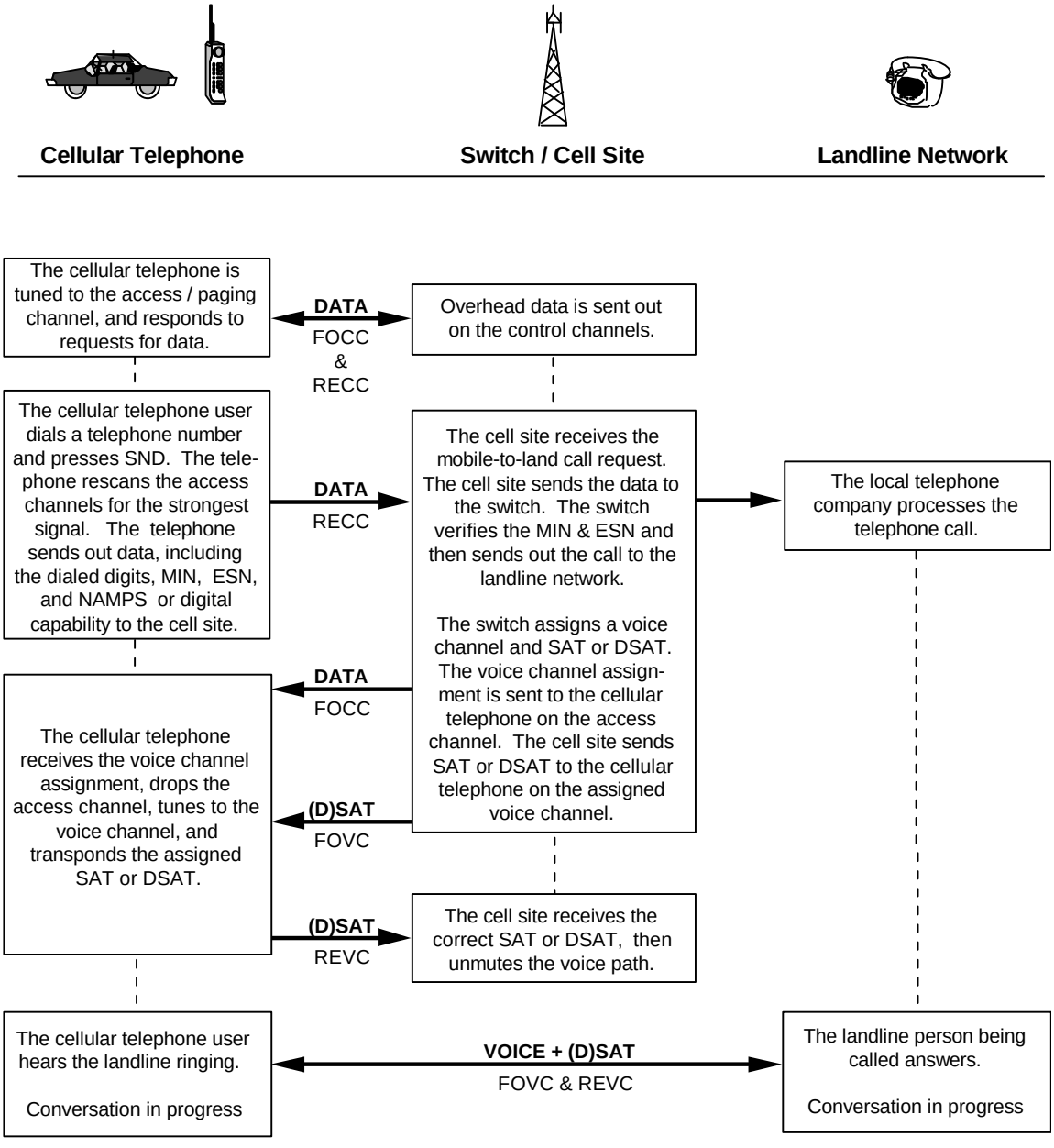

Going Into Service
With a Cellular Telephone
1. Power Up / Self Test
Turn on No Svc Indicator
2. Scan Preferred System (A or B)
3. Scan all 21 Control Channels
4. Tune to Strongest Control Channel
5. Receive Overhead Info ?
No
6. Tune to 2nd Strongest Channel
7. Receive Overhead Info ?
No*
Yes
Yes
Note: In order to turn on the Roam light, the SID in the overhead message stream must NOT match the SID programmed into the telephone.
8. SID matches Home SID ?
No
9. Turn on Roam Indicator
Yes
10. Turn Off NoSvc Indicator
Note: In order to turn off the NoSvc light, the overhead message stream must have been decoded.
11. Idle [Rescan after 5 minutes.]
12. Turn On NoSvc Indicator
13. Switch to Non-Preferred System

* In those telephones with Motorola Enhanced Scan, more than two control channels are sampled before proceeding to step 12.

Placing a Call (Mobile to Land or Mobile to Mobile)

When the cellular telephone user originates the call, the cellular telephone re-scans the access channels to assure that it is still tuned to the strongest one. The cellular telephone then transmits data at the rate of 10 kilobits per second on the control channel to notify the switch of its mobile identification number (MIN) and the number it wants to reach. The switch verifies the incoming data and assigns a voice channel and a SAT (or DSAT for NAMPS channels) to the telephone.

Figure 7. Cellular Telephone to Land Call Processing


Cellular Telephone
Switch / Cell Site
Landline Network
The cellular telephone is tuned to the access / paging channel, and responds to requests for data.
DATA
FOCC & RECC
Overhead data is sent out on the control channels.
The cellular telephone user dials a telephone number and presses SND. The telephone rescans the access channels for the strongest signal. The telephone sends out data, including the dialed digits, MIN, ESN, and NAMPS or digital capability to the cell site.
DATA
RECC
The cell site receives the mobile-to-land call request. The cell site sends the data to the switch. The switch verifies the MIN & ESN and then sends out the call to the landline network.
The switch assigns a voice channel and SAT or DSAT. The voice channel assignment is sent to the cellular telephone on the access channel. The cell site sends SAT or DSAT to the cellular telephone on the assigned voice channel.
The local telephone company processes the telephone call.
DATA
FOCC
The cellular telephone receives the voice channel assignment, drops the access channel, tunes to the voice channel, and transponds the assigned SAT or DSAT.
(D)SAT
FOVC
(D)SAT
REVC
The cell site receives the correct SAT or DSAT, then unmutes the voice path.
The cellular telephone user hears the landline ringing.
Conversation in progress
VOICE + (D)SAT
FOVC & REVC
The landline person being called answers.
Conversation in progress

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The cellular telephone tunes to the assigned voice channel and verifies the presence of the proper forward SAT frequency (or DSAT message). If SAT (DSAT) is correct the telephone transponds SAT (DSAT) back to the cell site and unmutes the forward audio. The cell site detects reverse SAT (DSAT) from the cellular telephone and unmutes reverse audio. At this point both forward and reverse audio paths are unmuted and the cellular telephone user can hear the other end ring, after which conversation can take place. SAT (DSAT) is sent and received more or less continuously by both the base station and the cellular telephone. However, SAT (DSAT) is not sent during data transmissions, and the cellular telephone does not transpond SAT continuously during VOX operation. Also, DSAT is suspended during the transmission of DST. Notice that SAT and Signaling Tones are only used on AMPS voice channels, and that the Signaling Tone is only transmitted by the cellular telephone.

Receiving a Call (Land to Mobile)

Once a cellular telephone has gone into service, it periodically scans the overhead message information in its memory and monitors the paging messages for its telephone number. When a page match occurs the cellular telephone scans each of the access channels and tunes to the strongest one. The cellular telephone then acknowledges the page on that access channel and thus notifies the central controller of its cell location. The switch then assigns a voice channel and a SAT (DSAT) to the cellular telephone. The cellular telephone tunes to the voice channel, verifies the presence of the proper SAT frequency (DSAT message) and transponds the signal back to the cell site. At the cell site, the reception of SAT (DSAT) signals the central controller that the cellular telephone is ready for the call. An alert order is then sent to the cellular telephone which responds with a 10 KHz signaling tone (DST message). The subscriber unit rings for 65 seconds or until the user answers. Then the 10 KHz signaling tone (DST message) is terminated to alert the central controller that the user has answered. The switch then connects the incoming call to the appropriate circuit leading to the cell in contact with the cellular telephone. At this point both forward and reverse audio paths are unmuted and the conversation can take place. SAT (DSAT) is sent more or less continuously by the base station and transponded by the cellular telephone, except during data transmission. DSAT is suspended during DST transmission, and during VOX operation SAT (DSAT) is not transponded continuously by the cellular telephone.

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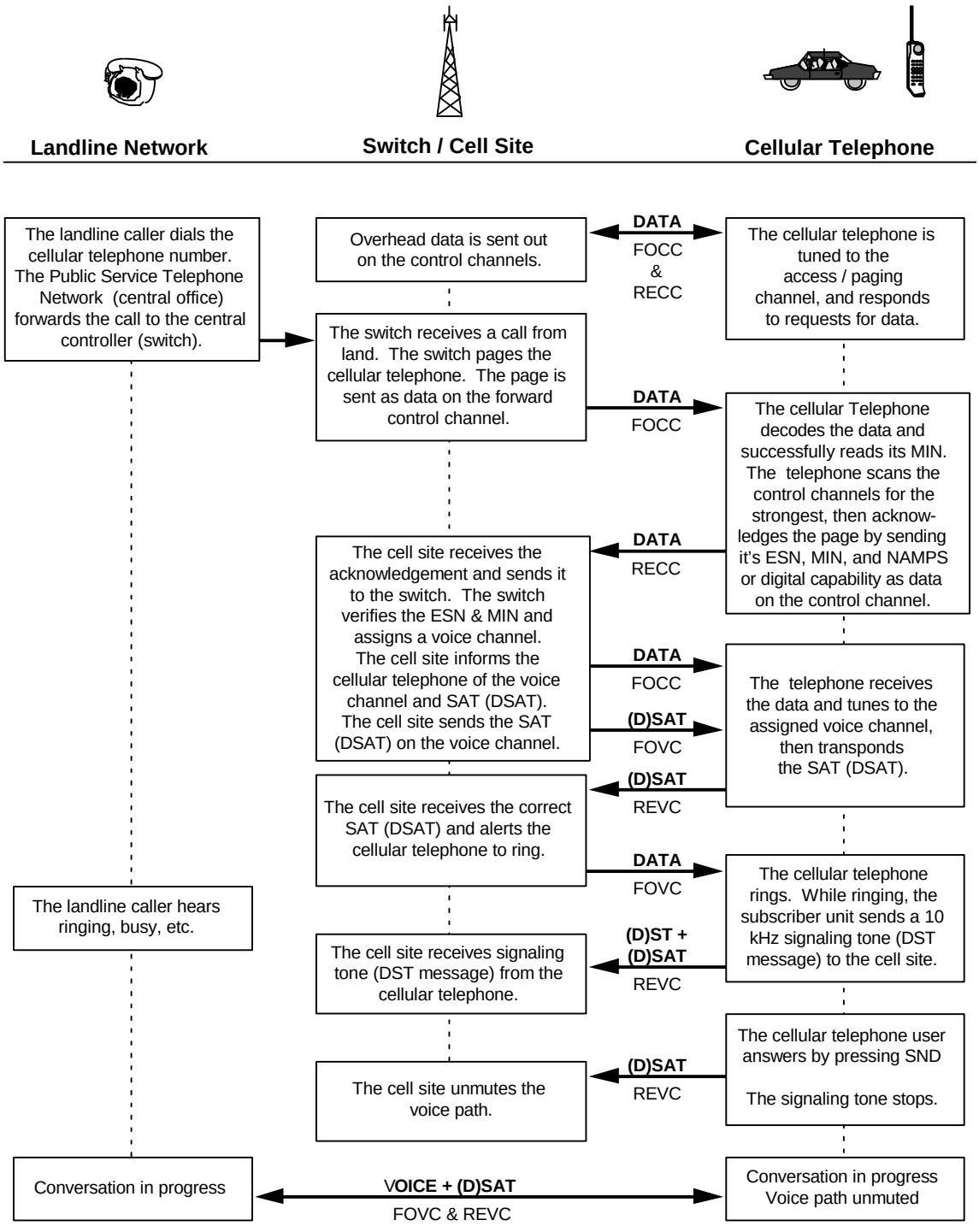
Figure 8. Land to Cellular Telephone Call Processing


Landline Network
Switch / Cell Site
Cellular Telephone
The landline caller dials the cellular telephone number. The Public Service Telephone Network (central office) forwards the call to the central controller (switch).
Overhead data is sent out on the control channels.
DATA
FOCC & RECC
The cellular telephone is tuned to the access / paging channel, and responds to requests for data.
The switch receives a call from land. The switch pages the cellular telephone. The page is sent as data on the forward control channel.
DATA
FOCC
The cellular Telephone decodes the data and successfully reads its MIN. The telephone scans the control channels for the strongest, then acknowledges the page by sending it's ESN, MIN, and NAMPS or digital capability as data on the control channel.
DATA
RECC
The cell site receives the acknowledgement and sends it to the switch. The switch verifies the ESN & MIN and assigns a voice channel. The cell site informs the cellular telephone of the voice channel and SAT (DSAT). The cell site sends the SAT (DSAT) on the voice channel.
DATA
FOCC
(D)SAT
FOVC
The telephone receives the data and tunes to the assigned voice channel, then transponds the SAT (DSAT).
(D)SAT
REVC
The cell site receives the correct SAT (DSAT) and alerts the cellular telephone to ring.
DATA
FOVC
The cellular telephone rings. While ringing, the subscriber unit sends a 10 kHz signaling tone (DST message) to the cell site.
The landline caller hears ringing, busy, etc.
(D)ST +
(D)SAT
REVC
The cell site receives signaling tone (DST message) from the cellular telephone.
The cellular telephone user answers by pressing SND
The signaling tone stops.
(D)SAT
REVC
The cell site unmutes the voice path.
Conversation in progress
VOICE + (D)SAT
FOVC & REVC
Conversation in progress
Voice path unmuted

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Power Steps

As a call progresses, the cell site continuously monitors the reverse channel for signal strength.

Every cellular telephone has a number of power steps ranging from full power (3 watts in a mobile and .6 watts in a portable) down to as low as about half a milliwatt. In reality all cellular telephones have eight power steps, but portable models are prevented from using the two highest power steps by the cell site. Transmit power level commands are sent to the cellular telephone as required to maintain the received signal strength within prescribed limits.

This is done to minimize interference possibilities within the frequency re-use scheme. If the signal received from the cellular telephone is higher than the prescribed limit (such as when the unit is very near the cell site), the subscriber unit will be instructed to step down to a lower level.

Hand-offs

If the cellular telephone is at its maximum allowed power for the cell site it is using and the received signal at the cell site is approaching the minimum allowable (typically -100 dBm), the cell site will signal the switch to consider the subscriber unit for a hand-off. The central controller (switch) will in turn have a scanning receiver at each of the surrounding cell sites measure the cellular telephone's signal strength. The site with the strongest signal will be the site to which the call will be handed to if there are available voice channels.

On an AMPS channel the hand-off is executed by interrupting the conversation with a burst of data (called blank and burst) containing the new voice channel assignment. The telephone acknowledges the order by a 50 millisecond burst of 10 kHz signaling tone on the originally assigned voice channel. The mobile telephone then drops the original voice channel and tunes to the newly assigned voice channel, keying up on that channel and transponding the assigned SAT. But on a NAMPS channel the hand-off is executed with a low speed data transmission that does not interrupt the voice. The telephone acknowledges the order in this case by a DST message. In either case, once the hand-off has been accomplished, the newly assigned cell site then alerts the switch that the hand-off has been completed, and the old voice channel is dropped.

It should be noted that this data exchange happens very quickly, lasting only as long as 260 milliseconds. However, when data or signaling tones are transmitted, audio is muted for the duration of that transmission and a syllable or two may be dropped from conversation. This is normally not a problem, but during data signaling, such as that employed for telefacsimile, answering machine, and computer communications, significant amounts of information may be lost. For this reason it is recommended that when THE Cellular Connection™ equipment is used the vehicle should be stationary to avoid data loss during hand-offs and other data transmissions. Otherwise the equipment should employ an error correction protocol.

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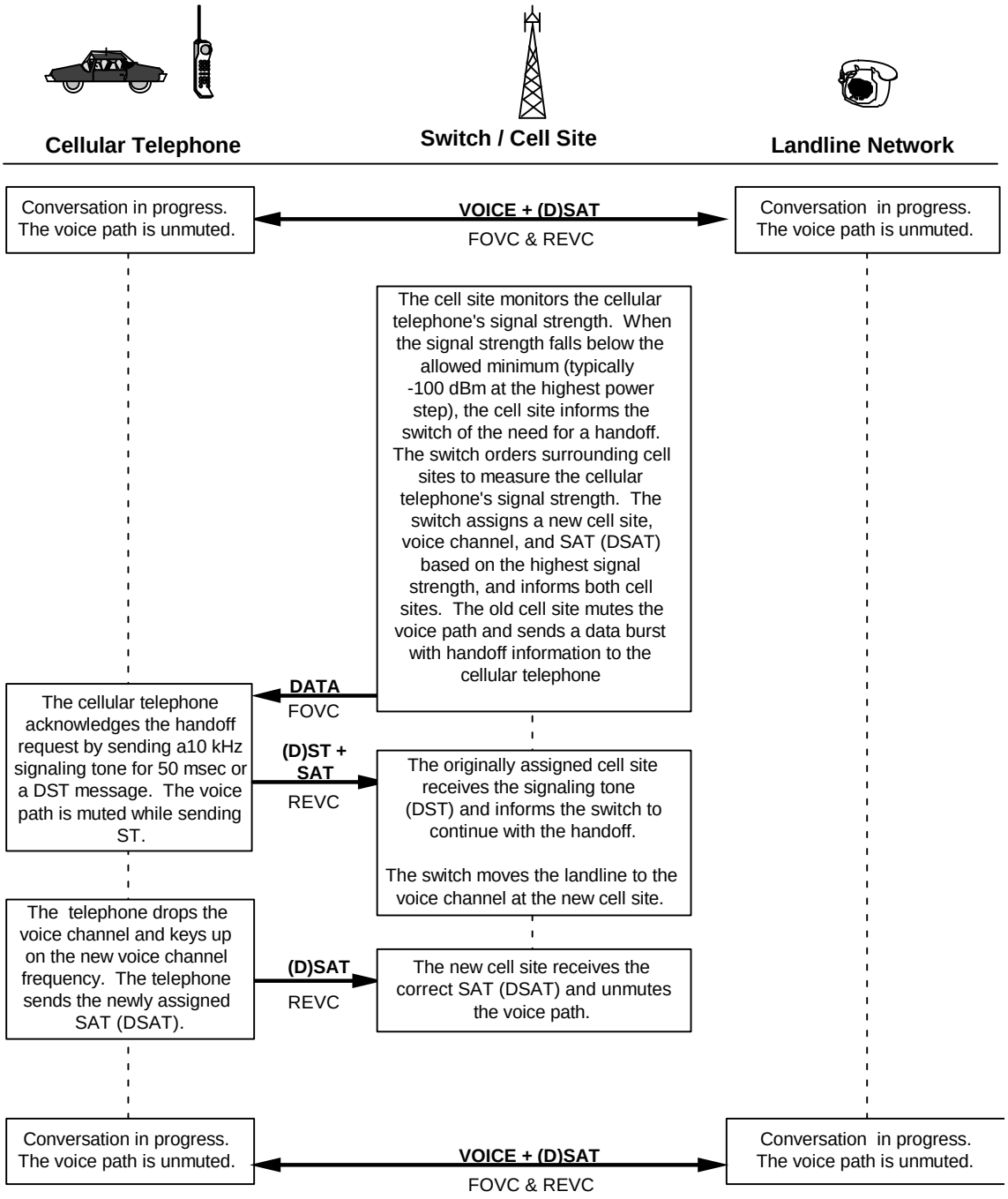
Figure 9. Cell Site Handoffs


Cellular Telephone
Switch / Cell Site
Landline Network
Conversation in progress. The voice path is unmuted.
VOICE + (D)SAT
FOVC & REVC
Conversation in progress. The voice path is unmuted.
The cell site monitors the cellular telephone's signal strength. When the signal strength falls below the allowed minimum (typically -100 dBm at the highest power step), the cell site informs the switch of the need for a handoff. The switch orders surrounding cell sites to measure the cellular telephone's signal strength. The switch assigns a new cell site, voice channel, and SAT (DSAT) based on the highest signal strength, and informs both cell sites. The old cell site mutes the voice path and sends a data burst with handoff information to the cellular telephone
DATA
FOVC
The cellular telephone acknowledges the handoff request by sending a10 kHz signaling tone for 50 msec or a DST message. The voice path is muted while sending ST.
(D)ST + SAT
REVC
The originally assigned cell site receives the signaling tone (DST) and informs the switch to continue with the handoff.
The switch moves the landline to the voice channel at the new cell site.
The telephone drops the voice channel and keys up on the new voice channel frequency. The telephone sends the newly assigned SAT (DSAT).
(D)SAT
REVC
The new cell site receives the correct SAT (DSAT) and unmutes the voice path.
Conversation in progress. The voice path is unmuted.
VOICE + (D)SAT
FOVC & REVC
Conversation in progress. The voice path is unmuted.

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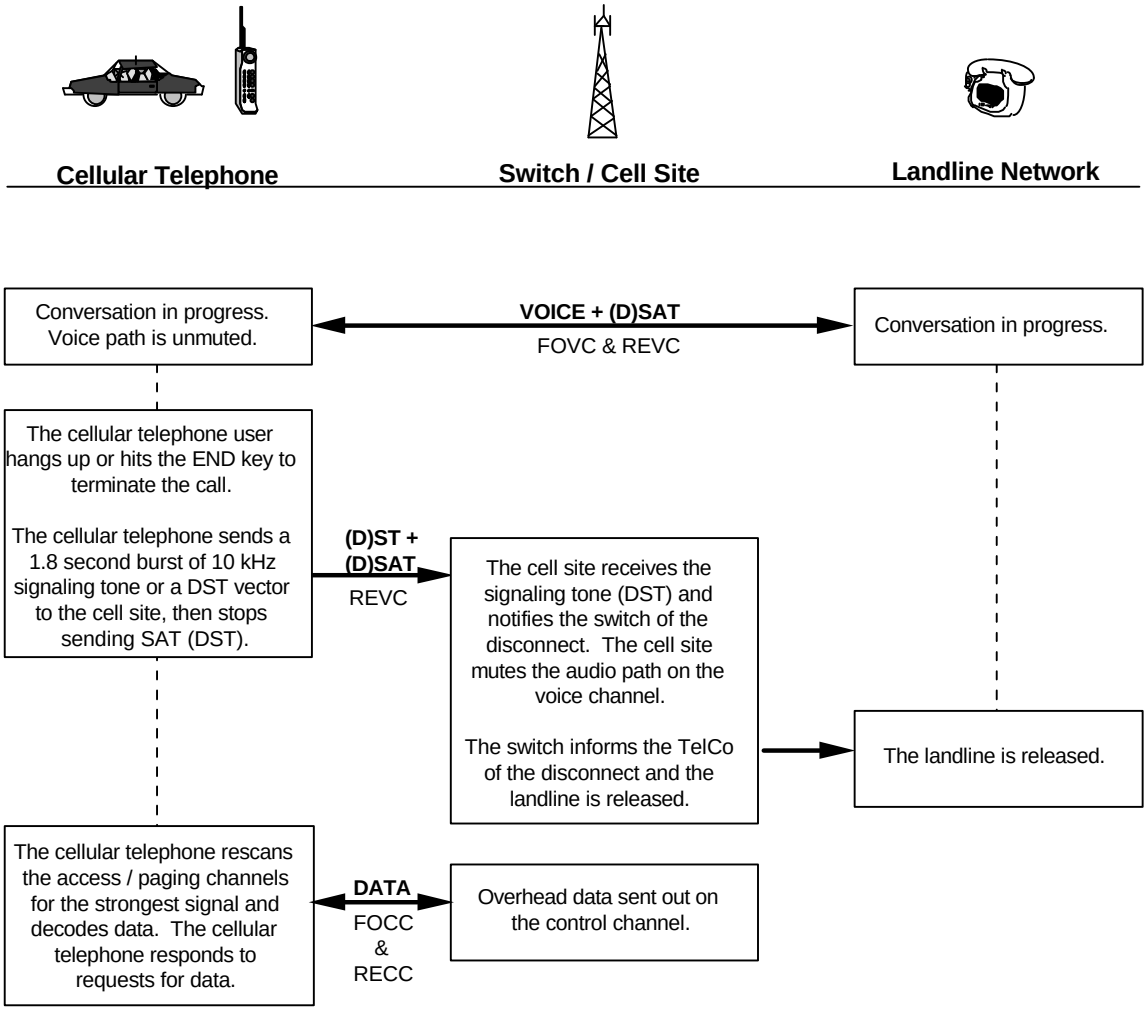
Call Termination

When the call is terminated by the landline caller (not the cellular telephone user), the central controller (switch) issues a release order to the subscriber unit. The cellular telephone acknowledges with a 10kHz signalling tone burst for 1.8 seconds and the cellular telephone ceases transmission.

If the call was terminated by the cellular telephone user, the telephone generates a 10kHz signalling tone burst for 1.8 seconds, indicating a call termination request to the switch. In either case after call termination, the cellular telephone goes back to rescan the nationwide set of forward controlchannels and repeats the Going into Service process it performed at first turn-on to re-establish itself on a paging channel.

Figure 10. Cellular Telephone Call Processing Termination


Cellular Telephone
Switch / Cell Site
Landline Network
Conversation in progress. Voice path is unmuted.
VOICE + (D)SAT
FOVC & REVC
Conversation in progress.
The cellular telephone user hangs up or hits the END key to terminate the call.
The cellular telephone sends a 1.8 second burst of 10 kHz signaling tone or a DST vector to the cell site, then stops sending SAT (DST).
(D)ST + (D)SAT
REVC
The cell site receives the signaling tone (DST) and notifies the switch of the disconnect. The cell site mutes the audio path on the voice channel.
The switch informs the TelCo of the disconnect and the landline is released.
The landline is released.
The cellular telephone rescans the access / paging channels for the strongest signal and decodes data. The cellular telephone responds to requests for data.
DATA
FOCC & RECC
Overhead data sent out on the control channel.

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Digital Cellular

Multiplexing

Using a single frequency to carry two or more communication links (e.g., conversations) is called multiplexing. There are two types of multiplexing that are feasible for cellular: code division multiplexing and time division multiplexing. Both code division multiplexing and time division multiplexing digitize voice before transmitting the signal. Another type of multiplexing, frequency division multiplexing, was briefly considered, then abandoned. We will deal with each type of multiplexing separately.

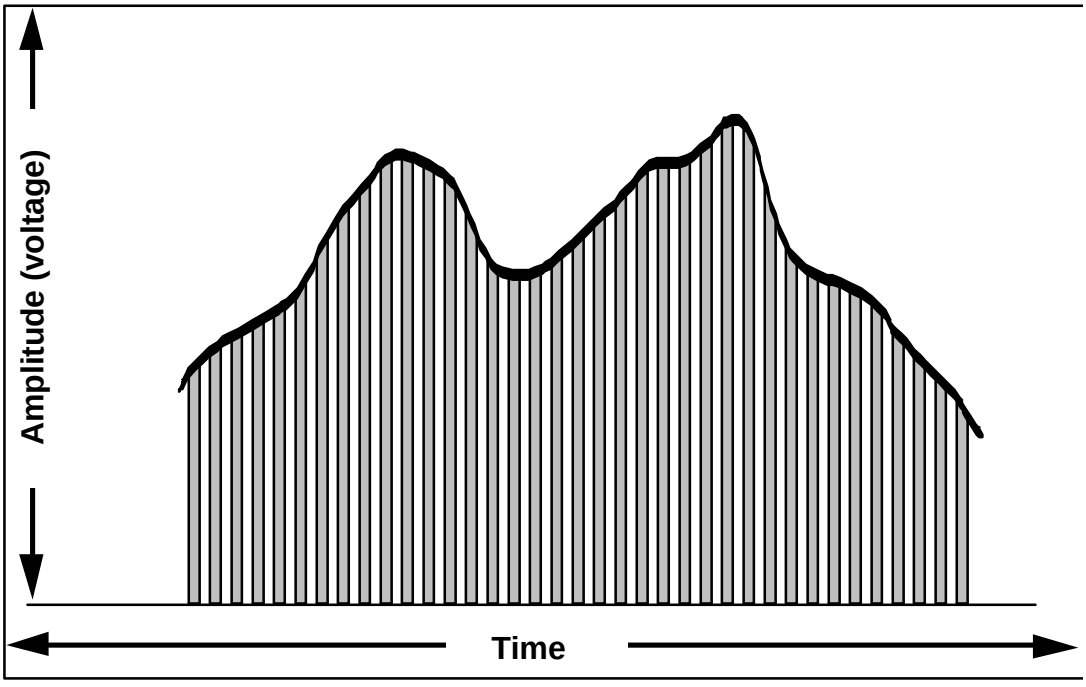
FDMA (Frequency Division Multiple Access)

Frequency Division Multiple Access (FDMA) uses two or more modulated subcarriers to modulate a third true carrier simultaneously. While as many as six communication links can be accommodated on a single frequency with FDMA, the bandwidth requirements are enormous. Given the relatively small 30 kHz bandwidth of cellular, FDMA was never a contender for improving the load carrying capacity of cellular systems. Also, it should be pointed out that FDMA is not necessarily digital.

Digitizing Voice

If a person speaks into a microphone, a transducer in the microphone converts the mechanical air movements produced by the person's vocal cords into varying voltages. If an oscilloscope probe is connected to the output from a microphone, a varying voltage

Figure 11. Digitizing Voice



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line, such as that shown in the accompanying illustration, will be produced.

If the varying voltages are sampled at some rate, the instantaneous voltages can be quantified. Let's say we want to quantify measurements from values of zero to 255 (the maximum value a binary byte can hold). The value of 255 would represent the highest possible voltage we could expect from voice, and zero would represent silence. Each discrete integer between zero and 255 would represent a particular voltage, typically presented in binary form.Because of the redundancies of speech and the inability of the human ear to detect more than a fraction of the intelligence in speech, it is possible to sample a small portion of the sound produced by a person speaking, reproduce that sound at either a later time or another place, then filter the resulting reproduction to produce a "sound" that is indistinguishable from the original source.

In the illustration on page 1 - 19 we saw how speech could be sampled at some rate. Suppose we take only one of every three samples. If our sampling rate is fast enough, and if we can compress the samples, it turns out that we can interleave several different conversations (communication links) on a single frequency. However, we also have to provide some mechanism for ensuring that the transmitter and receiver are in synchronization, and we have to provide for some alternative to the control and response tones used in conventional AMPS. All of these non-voice signals are digital and take time from the assigned time slot, leaving only a relatively small amount of time to represent voice. For this reason the digital receiver has to filter the audio to closely approximate the original audio.

TDMA (Time Division Multiple Access)

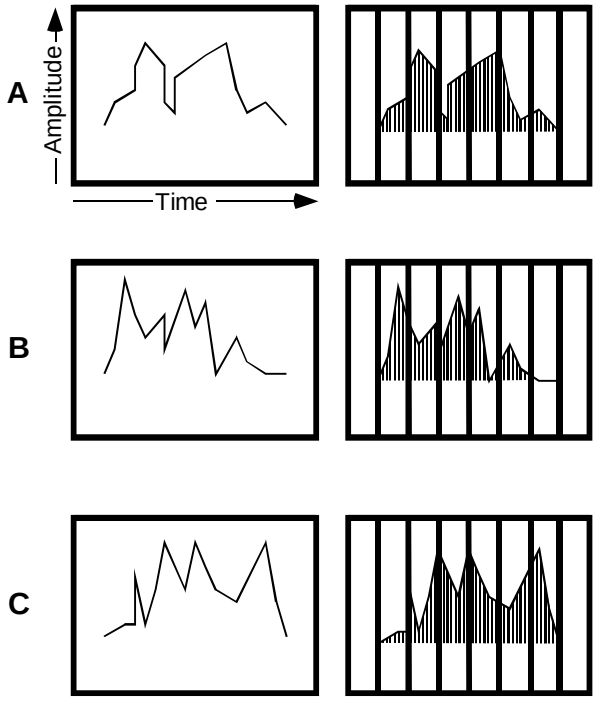
Time Division Multiple Access (TDMA) today provides a times-3 increase in the number of communication links a channel can carry (just like NAMPS). Eventually TDMA is expected to take full advantage of all six time slots, allowing for six communications links in the bandwidth of a conventional AMPS channel.

TDMA, like CDMA, employs a form of phase shift keying to represent symbols. However, TDMA also compresses the digitized signal, making use of predictive algorithms to reduce the number of symbols actually transmitted.

Digitization and TDMA

Here three conversations, represented by

Figure 12. Digitization and TDMA



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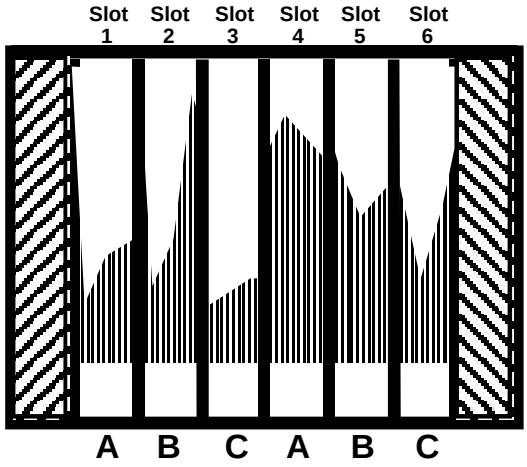
voice samples as viewed on oscilloscopes, are clearly shown to be nothing more than varying voltages produced by microphones. Instantaneous samples are discrete voltages. It has been shown that if the sampling rate is fast enough, it is possible to make a faithful representation of each conversation.

If these samples are then compressed, it is possible for more than a single conversation to occur on a single medium (such as a radio frequency) by sharing time slots. Here we see three conversations being shared on six time slots. The conversations shown are compressed sampled analog audio, not yet digitized.

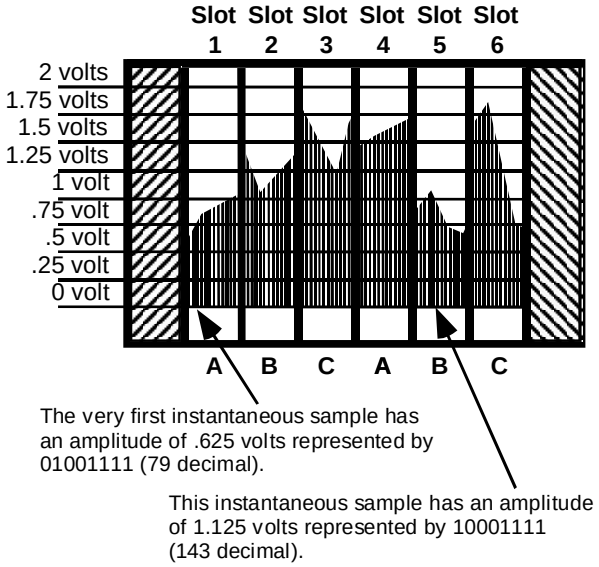
Figure 13. Slot Assignments



Digitization of Voltage

A byte, consisting of 8 bits, holds 256 possible numbers (0 through 255). If the maximum voltage we might expect from our voice samples is 2 volts, we can arbitrarily match those voltages proportionally to our byte. The result is a binary string representing voltages. We now have digital voice.

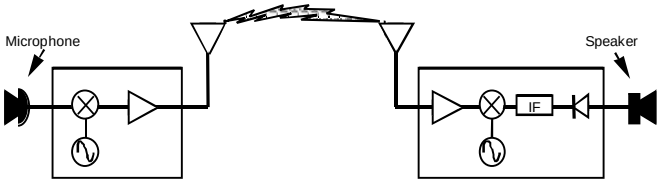
Figure 14. Digitization of Voltage



Conventional Radio

Radio uses transmitters to convert speech to radio energy and receivers to convert radio energy back to speech. In conventional analog radio, speech is converted into varying voltages called audio by a microphone. The

Figure 15. Convetional Radio



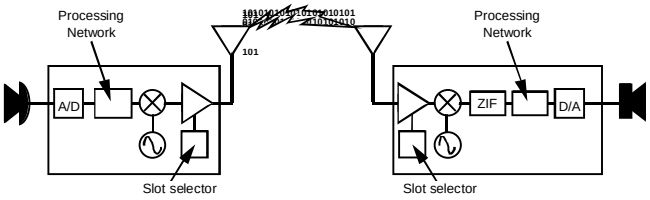
audio is mixed with a carrier frequency, amplified, and propagated through space as radio energy by an antenna. At the remote receiver an antenna converts the received radio energy to varying voltages at radio frequencies. The RF energy is beat against the output from a local oscillator to produce a difference frequency called the intermediate

frequency. The IF is processed in the IF strip, which provides filtering and amplification. A discriminator retrieves audio from the IF and the varying voltages of the audio are used to drive a speaker

TDMA Radio

TDMA radios use the same circuitry as analog radios, for the most part, but also have additional circuitry to convert analog audio to digitized form and vice versa, and to select the appropriate time slot.

Figure 16. TDMA Radio



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Accessories

STANDARD TRAVEL CHARGER

350 mAh Economy Travel Charger (Fixed Plug)

- o Argentina SPN4678A
- o Australia SPN4683A
- o Brazil 220 ..... SPN4679A
- o Brazil 110 ..... SPN4707A
- o China SPN4677A
- o Euro 220 ..... SPN4682A
- o India (Small 5 Amp) SPN4684A
- o U.K. SPN4680A
- o U.S. SPN4681A

VEHICLE POWER ADAPTER SYN8087A

- o Provides virtually unlimited in-vehicle use.
- o Conserves phone's battery power while simultaneously providing a rapid battery charge.

EASY INSTALL HANDS-FREE KIT SYN8088A

- o Easy -Install Hands Free Car Kit (Analog Audio)
- o Includes Car Clip 2000 and Alligator Clip 2000

HEADSET

- o Headset (Mono) SYN6962A
- o Retractable Headset (Mono) SYN8284A
- o Headset with Boom Microphone (Mono) SYN8146A

BELT CLIP

- o Universal Belt Clip (spinning) SYN7158A
- o Universal Belt Clip (locking) SYN8092A

PHONE CLIPS

- o Shark "Z Look" Phone Clip SYN8523A
- o Shark "R Look" Phone Clip SYN85234A

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BATTERY DOORS

o Battery Door - Z Look (Black) SHN7282A
o Battery Door - R Look (PUTTY GRAY) SHN7476A
o Battery Door - R Look (GUNMTL BLACK) SHN7477A
o Battery Door - R Look (METALLIC ORANGE) SHN7478A

BATTERIES

o AAA Long Battery 700 mAh NiMH (Q/A: 3) - English SNN5518A
o AAA Long Battery 700 mAh NiMH (Q/A: 3) - China SNN5541A
o AAA Long Battery 700 mAh NiMH (Q/A: 3) - Enlish/Port./Span. SNN5542A
Note: Q/A = Quantity per Assembly

IN-VEHICLE CLIPS

o Car Clip compatible w/Belt Clip-On System SYN8184A
o Alligator Clip compatible w/Belt Clip-On System SYN8185A
o Car Clip 2000 (compatible with Shark Belt Clip-On System) SYN8525A
o Alligator Clip 2000 (compatible with Shark Belt Clip-On System) SYN8526A

*** The use of wireless devices and their accessories ("devices") may be prohibited or restricted in certain areas. Always obey the laws and regulations on the use of these devices.**
**** All talk and standby times are approximate and depend on network configuration, signal strength and features selected. Talk times and standby times are lower when in analog mode.**

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TDMA Easy NAM Programming

Introduction

The Number Assignment Module (NAM) is a section of memory that retains information about the phone's characteristics, such as the assigned telephone number, system identification number, and options information.

Two methods are available to program the NAM using the keypad: Test Mode and User Mode.

Regardless of the method used, the NAM must be programmed before the phone can be placed into service. This chapter covers the NAM Programming steps for Easy NAM Programming which is the preferred programming method

User Mode Programming

User Mode NAM programming requires a special key sequence to enter, but can be accomplished through the telephone keypad without the use of any specialized hardware.

The telephone number can be changed up to fifteen times, after which the phone must be reset in Manual Test Mode using the **32#** command (erasing all repertory memory and initializing counters).

Some models may be available with a "User Mode NAM Programming Manual" which describes the entry key sequences and the programming steps for User Mode NAM programming.

User Mode NAM programming steps are different from Test Mode NAM programming steps, and do not include all of the option bits available in Test Mode NAM programming.

Access to User Mode NAM programming can be disabled by Test Mode NAM programming step 11, bit C7. Detailed description on Test Mode NAM Programming can be found in the TDMA Test Mode Nam Programming section of this manual.

The following page describes the step by step procedure for Easy NAM Programming, which is the preferred programming method.

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Programming Sequence

Enter Programming Mode ❶ Press (#) , carrier system ID (from your Cellular Service Provider), (#) , (*) , (snd). Phone displays " NAM 1 Prog * = Yes # = No".

❷ Press (*). Display prompts for Security Code "_ _ _ _ _ _".

Enter Security Code ❸ Press (0+) ,(0+) ,(0+) ,(0+) ,(0+) , (0+) (factory set). Phone displays ESN (Electronic Security Number).

❹ Press (snd) . Phone prompts for Phone Number " Phon # _ _ _ _ _ _ _ _ _ _".

Enter Phone Number ❺ Enter the entire Phone Number "_ _ _ _ _ _ _ _ _ _". Press (SEND) Phone displays " NAM Program Begins ".
The phone will turn off. When you turn the phone back on, the phone number will be programmed.

Programming a second No. Press (#), carrier system ID , (#) , (2ABC) , (#) , (*) , (SEND) .
Continue with steps ❷ - ❺ .
Be sure to check with the carrier of the second telephone number for the system ID.

If you make a mistake Try again will appear and you can re-enter the number. Press (CLR) to erase a single digit or press and hold (CLR) to erase the entire entry. Press (snd) when you are finished.

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TDMA Test Mode NAM Programming

Introduction

The Number Assignment Module (NAM) is a section of memory that retains information about the phone's characteristics, such as the assigned telephone number, system identification number, and options information.
Two methods are available to program the NAM using the keypad: Test Mode and User Mode.

Regardless of the method used, the NAM must be programmed before the phone can be placed into service. This chapter covers the NAM Programming steps for Test Mode NAM Programming.

Entering Test Mode NAM Programming

The recommended Manual Test Mode setup for NAM programming phones are described in "Entering Manual Test Mode" on page 33. Refer to "Test Connections" on page 38 to see the recommended test setup for performing Servicing Level manual tests.

The phone is in Status Display mode after powering up in Manual Test mode. To enter NAM Programming mode, first press the # key for at least two seconds to suspend the Status Display. Then enter 5 5 #. The phone will now be in Step 1 of the NAM.

NAM Programming Steps

There are 19 steps in the NAM. For each step, the display shows factory default NAM data. When new data is entered via the keypad the display scrolls from left to right.

Use the * key to sequentially step through the NAM data fields, entering new data as required, or skipping past factory default values for parameters that do not need to be changed.

Table 6, "Minimum Required Test Mode NAM Programming Steps", shows the minimum required Test Mode NAM programming steps. The programming steps not listed in this table can be "stepped through", retaining the factory default values for those steps.

Table 7, "Test Mode NAM Programming Sequence," on page 3 lists all NAM programming steps, complete with parameters and definitions.

Table 6. Minimum Required Programming Steps

Service Type	Minimum Required Programming
Single NAM	1, 3, 4, 6, 9
Dual NAM Enable	11
Dual NAM	1, 3, 4, 6

NAM Data

NAM Data is specified by the system operator. For most NAM steps, the information specified by the system operator is the same as the factory default data.

The factory default System ID (step 01) and User Telephone Number (step 03) must always be changed.

Other portions of the factory default NAM data must sometimes be modified to conform to special system requirements, or to enable/ disable certain features.

If a second phone number is to be programmed, step 11 C Option Byte, bit 6 must be set to 1. This bit enables dual-NAM operation and will cause NAM program-ming steps 1-6, 12, and 16 to be repeated for the second phone number.

User Mode Programming

User Mode NAM programming requires a special key sequence to enter, but can be accomplished through the telephone keypad without the use of any specialized hard-ware. The telephone number can be changed up to fifteen times, after which the phone must be reset in Manual Test Mode using the 32# command (erasing all repertory memory and initializing counters).

Some models may be available with a "User Mode NAM Programming Manual" which describes the entry key sequences and the programming steps for User Mode NAM programming.

User Mode NAM programming steps are different from Test Mode NAM programming steps, and do not include all of the option bits available in Test Mode NAM programming. Access to User Mode NAM programming can be disabled by Test Mode NAM programming step 11, bit C7.

NOTE

Changed NAM values are not stored until pressing ***** after Step 19 (Step 16 if a second phone number was entered.)

IMPORTANT

Consult with the System Operator regarding NAM information. Incorrect
NAM entries can cause the phone to

Test Mode NAM Programming Sequence

Advances to the next programming step; also programs the NAM after the last programming step is entered.

Clears the entered information and displays previously entered data for the current programming step.

Exits the programming mode without programming the NAM.

Table 7. Test Mode NAM Programming Sequence

Step	Factory Default	Description
01	00000	**System ID Number**. Number assigned by system operator for system identification.
02	10110101 (A7-A0)	**A OPTION BYTE.** The display for step 02 represents the status of eight options, A7 through A0. Bit A7 (msb) is programmed first, followed by A6-A0. Bits enter display on the right and scroll left.
	1	**Local Use (Bit A7).** If set to 1 phone will respond to local control orders in the home area or when the group ID is matched. Assigned by system operator.
	0	**Preferred System (Bit A6).** Applies to units capable of operating on two service systems (A or B). 0 = system B; 1 = system A.
	1	**End-to-End Signaling (Bit A5).** When enabled, the phone is equipped for DTMF signaling during a call. 1 = enabled, 0 = disabled.
	1	**Authentication Enable (Bit A4).** Enter 1.
	0	**Bit not used (Bit A3).** Enter 0.
	1	**Auxiliary Alert (Bit A2).** When enabled, the user can place an Extended System in auxiliary alert mode and be notified of incoming calls via headlights, horn etc. 1 = enabled, 0 = disabled.
	0	**Bit not used (Bit A1).** Enter 0.
	1	**MIN MARK (Bit A0).** Supplied by system operator. When enabled the user's area code will be sent with each call initiated or answered. 1 = enabled, 0 = disabled.
03	0000000000	**User 10 digit radiotelephone phone number.** Number is assigned by system operator.
04	00	**Station class mark.** A 2 digit number assigned by the system operator. Indicates maximum power step, VOX capability, and number of channels used.
05	00	**Access overload class.** Specifies the level of priority assigned to the phone when accessing the system. Assigned by system operator.
06	00	**Systems group ID mark.** Specifies how many bits of the system ID are compared during call processing. Assigned by system operator.

Table 7: Test Mode NAM Programming Sequence (con't)

07	000000	**Security code.** A 6 digit number supplied by the user. This number is used by the user to access or change "security" features such as the 3-digit unlock code or the service level.
08	123	**Unlock code.** A 3 digit number supplied by the user. If the lock feature is enabled by the user, the phone can be operated only by individuals who know the unlock code.
09	4	**Service level.** This 3 digit number supplied by the user allows various call placement restrictions if desired. 004 = no restrictions.
10	00000100 (B7-B0)	**B OPTION BYTE** The display for step 10 represents the status of eight options, B7 through B0. B7 (msb) is programmed first followed by B6-B0. Bits enter display on the right and scroll left.
	0	**Bit not used (Bit B7).** Enter 0.
	0	**Bit not used (Bit B6).** Enter 0.
	0	**Bit not used (Bit B5).** Enter 0.
	0	**Bit not used (Bit B4).** Enter 0.
	0	**Single System Scan (Bit B3).** If set to 1, phone will scan only one system based on the setting of the preferred system bit (option bit A6). 1 = enabled, 0 = disabled.
	1	**Auto Recall (Bit B2).** When set to one, the user may access repertory by a one or two digit send sequence (speed dialing).
	0	**Disable Service Levels (Bit B1).** If set to 1, the service level (call restrictions) cannot be changed by the user.
	0	**Lock Disable (Bit B0).** When set to 1, the user cannot lock and unlock the phone unit via the 3 digit lock code.
11	00001000 (C7-C0)	**C OPTION BYTE** The display for step 11 represents the status of eight options, C7 through C0. C7 (msb) is programmed first followed by C6-C0. Bits enter display on the right and scroll left.
	0	**User Mode NAM Programming Disable (Bit C7).** When set to 1, User Mode NAM programming cannot be accessed.
	0	**Second Number Registration (Bit C6).** When set to 1, allows access to the second phone number.
	0	**Bit not used (Bit C5).** Enter 0.
	0	**Auto Redial Disable (Bit C4).** When set to 1, the user cannot access the 6-minute auto redial feature.
	1	**Speaker Disable (Bit C3).** This bit is used to disable internal handset speaker when adding V.S.P. option. 1 = handset speaker disabled, 0 = handset speaker enabled.
	0	**Bit not used (Bit C2).** Enter 0.
	0	**Selectable System Scan Disable (Bit C1).** When set to 1, the user cannot select the primary system.
	0	**Diversity Antenna Enable (Bit C0).** (Extended systems only) 0 = Non-diversity, 1 = Diversity.
12	0334	**Initial Paging System.** There are 4 significant bits for the initial paging channel. For system A enter 0333 and system B enter 0334.

Table 7: Test Mode NAM Programming Sequence (con't)

13	0333	**Initial A system channel.** To initialize system A enter 0333.
14	0334	**Initial B system channel.** To initialize system B enter 0334.
15	021	**Dedicated Paging Channels.** Number of dedicated paging channels is 21. Enter 021.
16	0737	**Secondary Initial Paging System.** There are 3 significant bits for the secondary initial paging channel. For system A enter 708 and system B enter 737. . Secondary initial paging channels are for digital applications, providing a secondary scan for a digital channel.
17	0708	**Secondary Initial A system channel.** To initialize system A enter 708.
18	0737	**Secondary Initial B system channel.** To initialize system B enter 737.
19	10111011	**D Option Byte.** The display for step 16 represents the status of eight options, D7 through D0. D7 (msb) is programmed first, followed by D6-D0. Bits enter display on the right and scroll to left.
	1	**Enhanced Scan Enable (Bit D7).** Enter 1.
	0	**Cellular Connection Enable (Bit D6).** Normally set to 0.
	1	**Long Tone DTMF Enable (Bit D5).** Normally set to 1.
	1	**Transportable Internal Ringer/Speaker Disable (Bit D4).** When set to 0, audio is routed to the accessory speaker of the transportable. When set to 1, audio is routed to the handset speaker. Normally set to 1.
	1	**Eight Hour Time-out Disable (Bit D3).** Normally set to 0.
	0	**Handset Test Mode Disable (Bit D2).** Enter 0.
	1	**Failed Page Indicator Disable (Bit D1).** When set to 1, the failed-call tone alert feature is disabled.
	1	**Word Sync Scan Disable (Bit D0).** Enter 1.

NOTE

If the second phone number bit is enabled, (step 11 C Option Byte bit 6), then steps 1- 6, 12, and 16 are repeated.
To store NAM data press the * key until the 'is displayed after step 19

Manual Test Mode

Introduction

Manual Test Mode software allows service personnel to monitor the telephone status on the display, and manually control tele-phone functions via the keypad.

Manual Test Mode operates at two levels: 1) Status Display level, which allows the phone to operate normally while providing status indications in the display; and 2) Servicing Level, which disables normal call-processing and allows commands to be entered through the keypad to manually control operation of the phone.

Entering Manual Test Mode

Manual Test Mode is entered by entering the following keypad sequence:

FCN 0 0 * * T E S T M O D E STO

Once this key sequence is completed the Status Display screen appears. Press and hold the # key for 2 seconds to enter in manual test mode.

Figure 19: "Connections for PCS Testing" on page 38 shows the recommended test setup.

Status Display Level

Status Display level is the power-up state in manual test mode. In this level of manual test mode the phone will place and receive calls as normal, but the display shows two lines of status information.

The display alternates between the channel number, RSSI status information, and primary status information:

- SAT frequency
- Carrier state
- Signaling tone state
- Power level
- Voice/data channel mode
- Audio states
- DVCC and BER measurements

The format of this status information is shown in Figure 17: "Test Mode Status Display (Analog Mode)" on page 35 and Figure 18: "Test Mode Status Display (Digital Mode)" on page 36.

When dialing a phone number, the status display ceases when the first digit of the phone number is entered. The telephone number is then displayed as it is entered. When the Snd, End, or Clr button is pressed, the status information display resumes. The phone remains in Status Display Mode if the # key is pressed momentarily.

Servicing Level

The Servicing Level of Manual Test Mode allows service personnel to manually control operation of a phone by entering commands through the telephone keypad. Parameters such as operating channel, output power level, muting, and data trans-mission can all be selected by entering the corresponding commands.

To enter the Servicing Level, press and hold the # button for at least 2 seconds while in Status Display level (power-up state of manual test mode.)

In the Servicing Level, automatic call processing functions are disabled, and the phone is instead controlled manually by keypad commands.

Table 3, "Test Commands For Manual Test Mode," on page 23 lists the commonly used manual test commands and the resulting display and telephone function for each command.

Figure 17. Test Mode Status Display (Analog Mode)

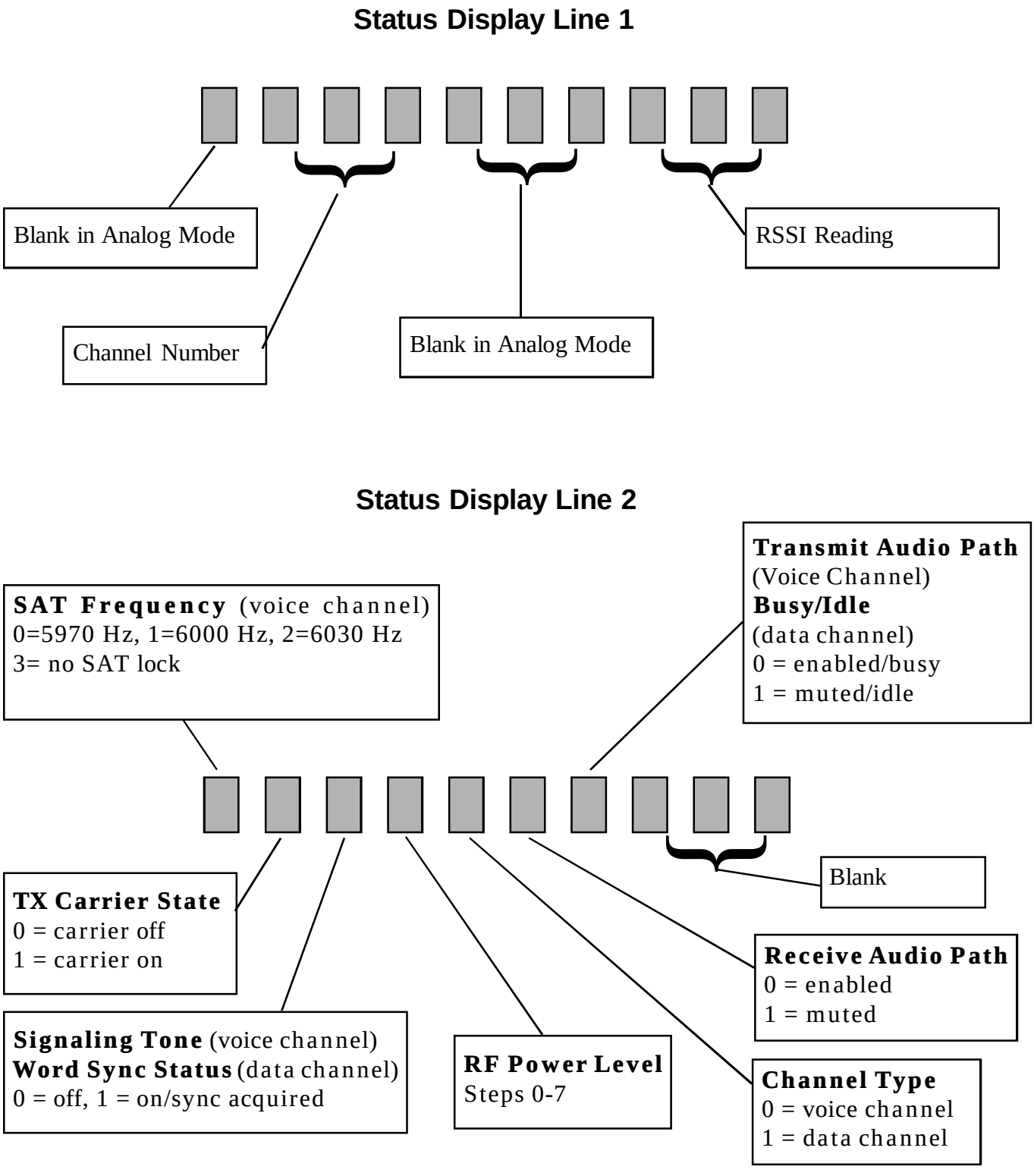
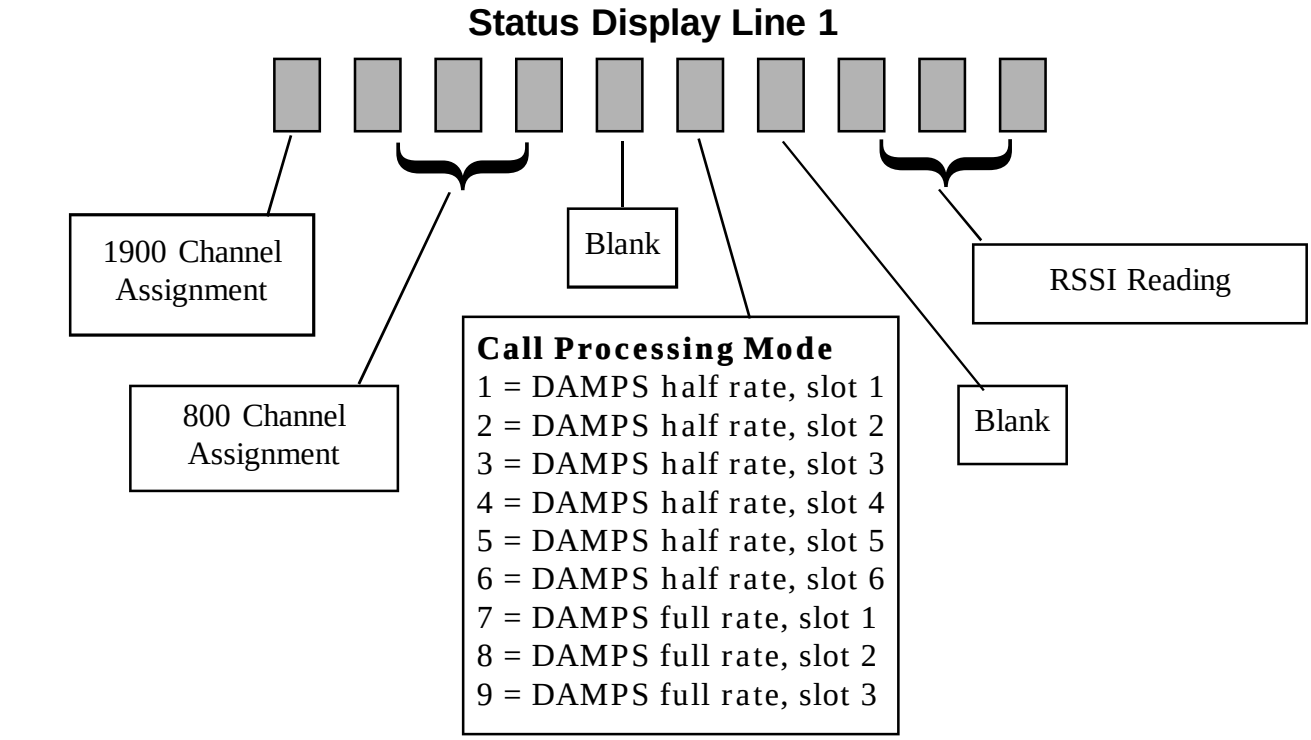
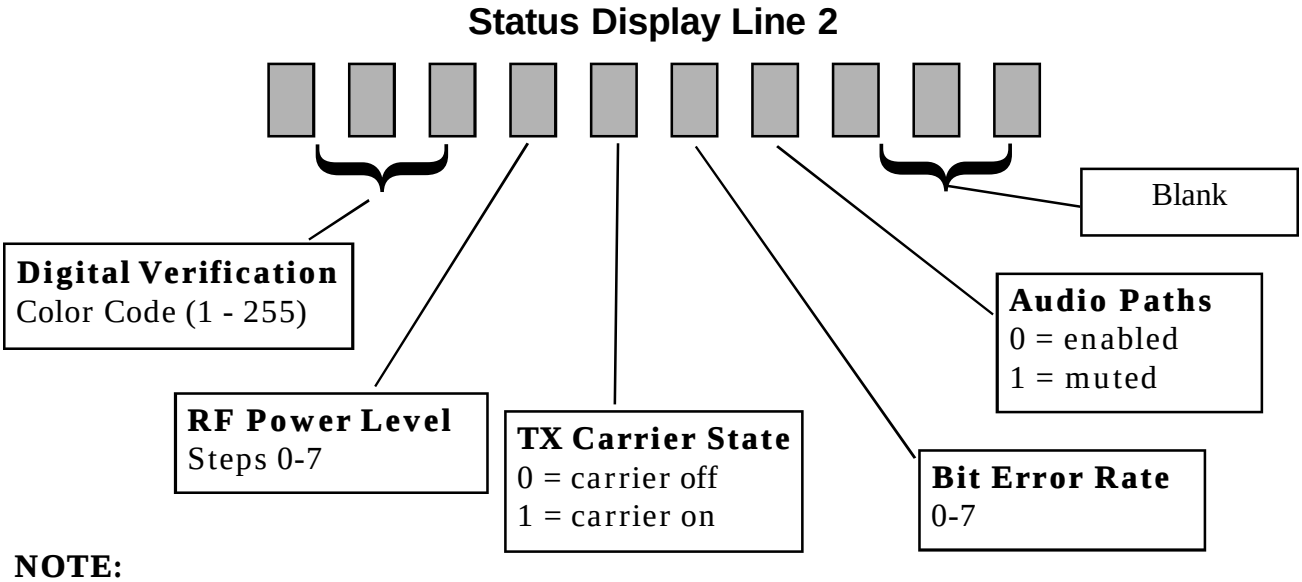


Figure 18. Test Mode Status Display (Digital


Status Display Line 1
1900 Channel Assignment
800 Channel Assignment
Blank
Call Processing Mode
1 = DAMPS half rate, slot 1
2 = DAMPS half rate, slot 2
3 = DAMPS half rate, slot 3
4 = DAMPS half rate, slot 4
5 = DAMPS half rate, slot 5
6 = DAMPS half rate, slot 6
7 = DAMPS full rate, slot 1
8 = DAMPS full rate, slot 2
9 = DAMPS full rate, slot 3
Blank
RSSI Reading



NOTE:
800MHz channels are displayed as three digits. Channel Numbers 1000-1023 are represented on the display as A00-A23.
1900MHz channels are displayed as four digits (0002 to 1998).

Test Procedures

Introduction

The phone allows keypad controlled testing of various analog and digital operating parameters.

This chapter includes the keypad button functions and recommended equipment setup to use when testing a phone.

Automatic Call-Processing Tests

Most communications analyzers can simulate a cell site in order to perform automatic call-processing tests. Automatic call processing tests can be performed while the phone is in its power-up state. However, it is useful to do the tests with the phone in Test Mode Status Display.

Refer to the communications analyzer's manual for details about performing call-processing tests. The following call-processing test sequence is recommended:

1. Inbound call, analog mode
2. Outbound call, analog mode
3. Analog-to-Analog channel handoff
4. Analog-to-Digital channel handoff
5. Inbound call, digital mode
6. Outbound call, digital mode
7. Digital-to-Digital channel handoff
8. Digital-to-Analog channel handoff

Handoffs should be performed between low, middle, and high frequency channels, such as, 991 (lowest frequency), 333 (middle frequency), and 799 (highest frequency). In digital mode slots 1 & 4, 2 & 5, and 3 & 6 should be verified.

Analog Test Measurements

- RX Sensitivity (SINAD)
- RX Audio Distortion
- TX Power Out
- TX Frequency Error
- TX Audio Distortion
- TX Maximum Deviation
- TX SAT Deviation
- TX ST Deviation

Digital Test Measurements

- Digital RX Sensitivity (BER)
- Digital Power Out
- TX Frequency Error
- Digital Modulation Stability (EVM)

The analog and digital parameters are stored in EPROM on the Transceiver Board. Each transceiver is shipped from the factory with these parameters already calibrated. However, if a board is repaired, these parameters should be measured and, if necessary, adjusted. Checking and adjusting calibration parameters is also useful as a troubleshooting/diagnostic tool to isolate defective assemblies.

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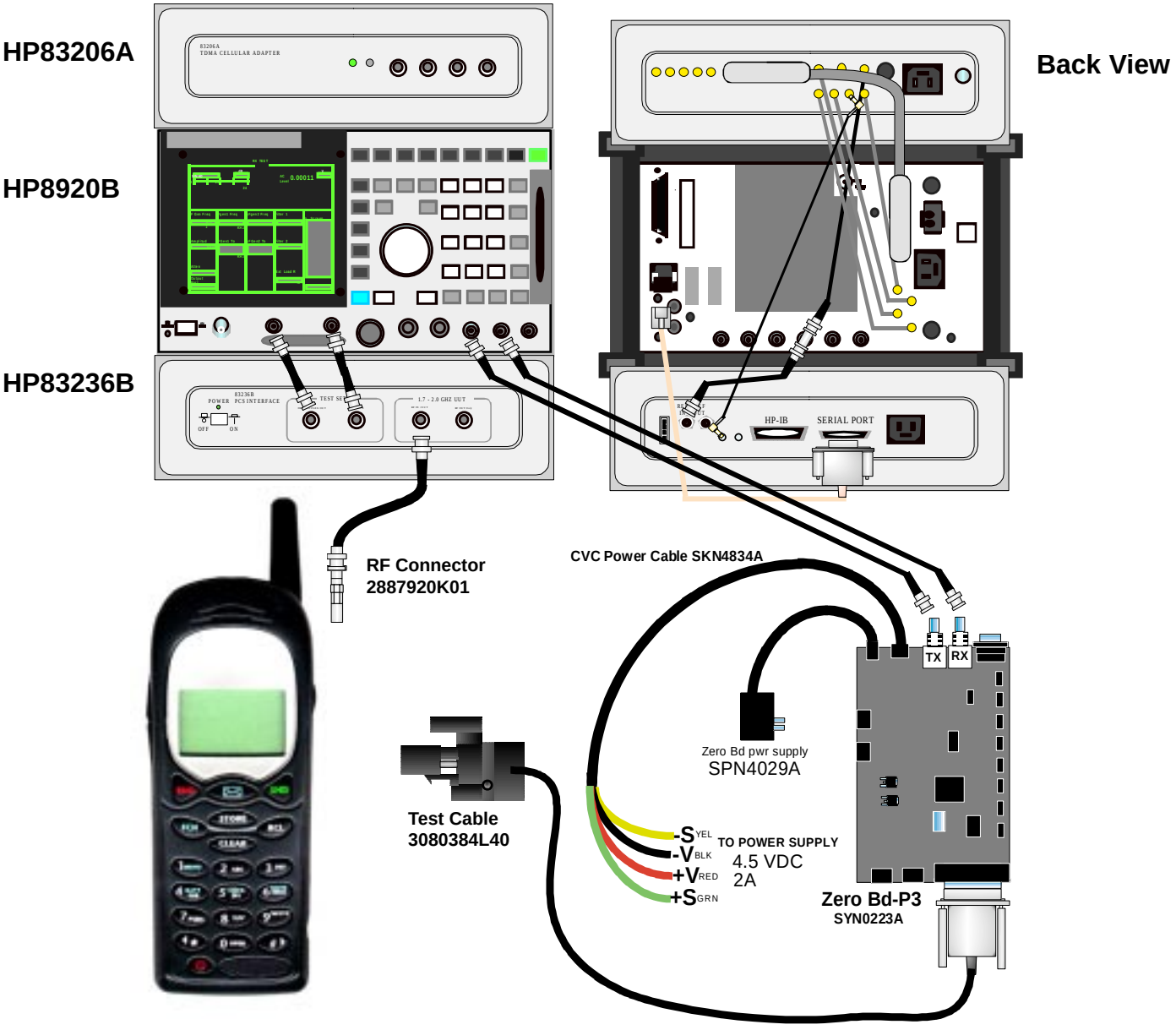
Test Connections

The diagram below shows the recommended connections for PCS testing when using the HP83236B PCS Interface with the HP8920B via Serial Port. Make sure to set the **HP-IB/ Ser** switch of the HP-IB Address Selector on the rear panel of the PCS Interface to "**Ser**."

The Zero Board test interface and an RF adapter with a low loss RF cable is used to interface with the communications analyzer.

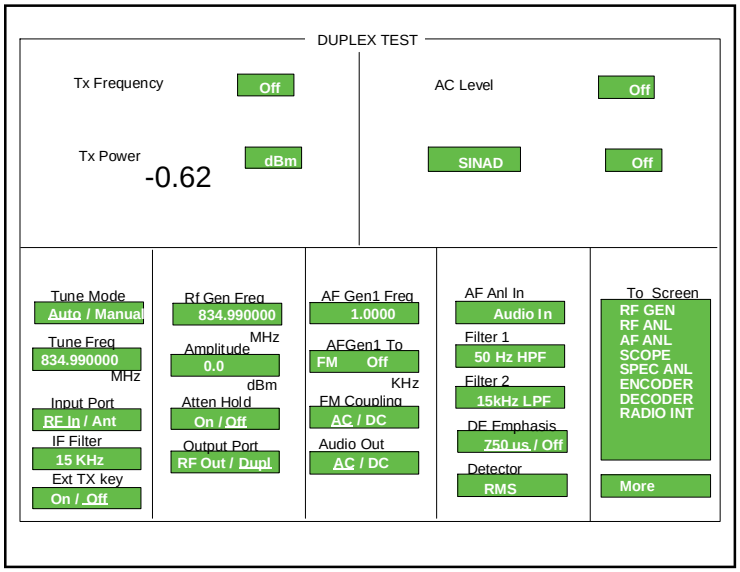
A variety of communications analyzers may be used. Refer to the analyzer manufacturer's user manual for proper setup before starting tests.

Figure 22. Connections for PCS Testing



RF Cable Test

Figure 23. Duplex Test Screen



To test the RF cable for proper loss:

- **Tune Freq** should be set to TX frequency: 834.990000 MHz.
- **RF Gen Freq** should be set to same frequency (834.990000 MHz).
- **Tx Power** should be set to read in dBm, not Watts.

In order to properly measure and adjust the parameters of a telephone, it is important that you use RF cabling that has minimal loss. Therefore, it is important that you test the RF cable for proper loss. This can easily be done by using the DUPLEX TEST screen of your HP8920. To test the cable, set up the DUPLEX screen as shown above.

Action:

Take the cable under test and connect it from the RF in/out port to the Duplex Out port. At this point you will be getting some type of power reading for cable loss.

Good range: -.2 dBm through -.8 dBm

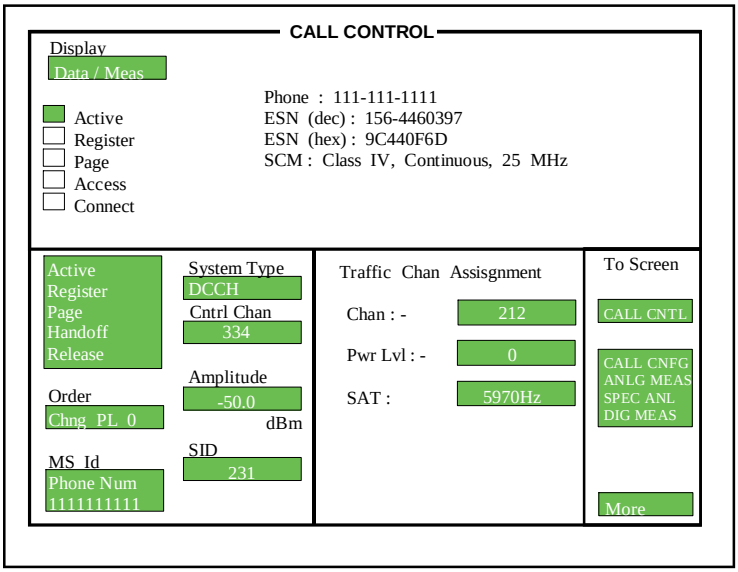
Bad cable: More than -.8 dBm

If the reading you are getting shows gain (positive number,) you may need to zero the power meter. This may happen on an HP8920 whose memory has just been cleared.

To zero the meter, press the **TX** button on the 8920 panel. Bring the cursor down to the field under **TX Pwr Zero** where it reads **Zero**. Tap the cursor on the Zero field and it will highlight for a moment as it zeroes the meter. Set up the screen as shown above, and test your cable.

Set up for Analog call

Figure 24. Call Control Screen



Select CALL CNTL from the To Screen

- Select System type: **AMPS**
- Zero the RF Power meter in the: **Call Config Screen**
- Set Amplitude to: **-50 dBm**
- Set SID: **Your phone's System ID**
- Select: **Active**
- **Voice Channel Assignment Type:**
- Chan: **212**
- Pwr Lvl: **4**
- SAT: **5970Hz**

Registration

1. Put the Test Set in Active state by selecting **Active** from the list on the left side of the screen.
2. Select **Data** from the **Data/Meas** field. This is the default mode.
3. Select **Register** from the list to register phone.
4. If the registration message has been received, the Test Set will display registration data in the upper half of the screen as shown in the sample screen above.

Page

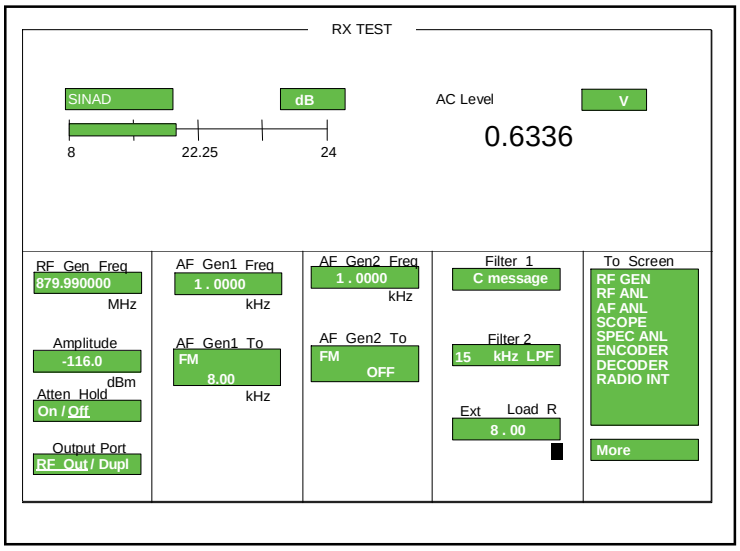
1 Select page from the list on the left side of the screen.
2 If the mobile responds, you will see the Access annunciator light briefly.
3 Answer the call by raising the flip or press SEND on the mobile to start the conversation.
4 The Connect annunciator lights. This is the Connect state.

Origination

1 Dial the desired phone number on the mobile station and press SEND.
2 The Access annunciator will light while the Test Set signals the mobile on the assigned voice channel.
3 The connect annunciator will light if the mobile properly signals the Test Set.

RX Sensitivity Test (SINAD)

Figure 25. RX Test Screen



Test Mode Commands:

11333#	Loads synthesizer to channel 333
08#	Unmute receive audio path
58#	Turn on compandor
474#	Set volume control to level 4
356#	Set RX audio path to Ext. Audio Path

Sinad measured on the communications analyzer must be more than 12dB.

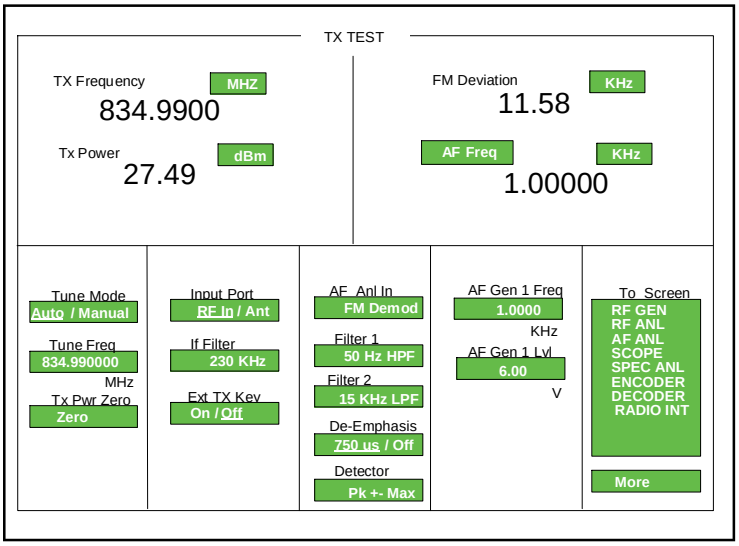
Duplex SINAD can be measured with the same setup by entering 122# and the 05# test command, which turns on the transmitter at power step 2. Narrow band SINAD can be measured by entering 571# and setting the FM Deviation to 3kHz. Refer to the RX troubleshooting section for radios not within the pass specifications.

Communications Analyzer Setup:

- Select **RX** button from the Screen Control panel
- Set **RX frequency** to **879.990 MHz**
- Set **Amplitude** to **-116 dBm**
- Set **AF gen1** to **1 kHz frequency** at **8 kHz deviation**, using **FM modulation** (PLEASE NOTE: this is for AMPS only; NAMPS uses much lower deviation)
- Set **AF Filter 1** set to **C message filtering**
- Set **AF Filter 2** to **15 kHz**

TX Power Out Test

Figure 26. TX Test Screen



Test Mode Commands:

11333#	Loads synthesizer to channel 333
12X#	Set power level to step X, where X is a power level from 1 to 7.
05#	Turns on transmit carrier

The TX Power Out specification for each portable power level is as follows:

Power Step 2	25dBm - 29dBm
Power Step 3	21.5dBm - 25.5dBm
Power Step 4	17.5dBm - 21.5dBm
Power Step 5	13.5dBm - 17.5dBm
Power Step 6	9.5dBm - 13.5dBm
Power Step 7	5.3dBm - 9.5dBm

Refer to the TX troubleshooting section for radios not within the pass specifications.

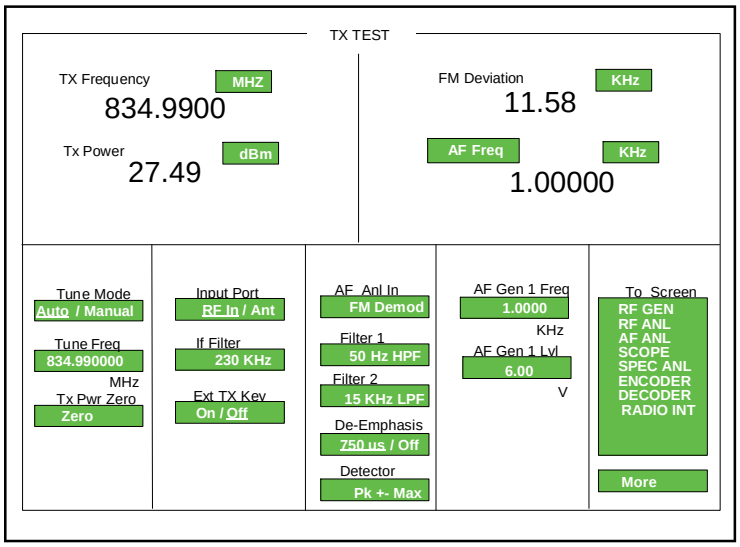
Note: When taking measurements, remember to compensate for cable loss.

Communications Analyzer Setup:

- **Select** TX **button from the Screen Control panel**
- **PWR** is measured in **dBm**
- Set **Frequency Measurement** to **auto or manual** (display will show TX Freq. Error)
- Set **TX frequency** to **834.990 MHz**
- Set **IF filter** to **230 kHz**
- Set **AF Filter 1** to **50 Hz**
- Set **AF Filter 2** to **15 kHz**
- Set **AF gen1** for **1 kHz frequency** at **6V level** (output will go to the **audio** port)

TX Frequency Error Test

Figure 27. TX Test Screen



Test Mode Commands:

11333#	Loads synthesizer to channel 333
122#	Set power level to step 2
05#	Turn on transmit carrier

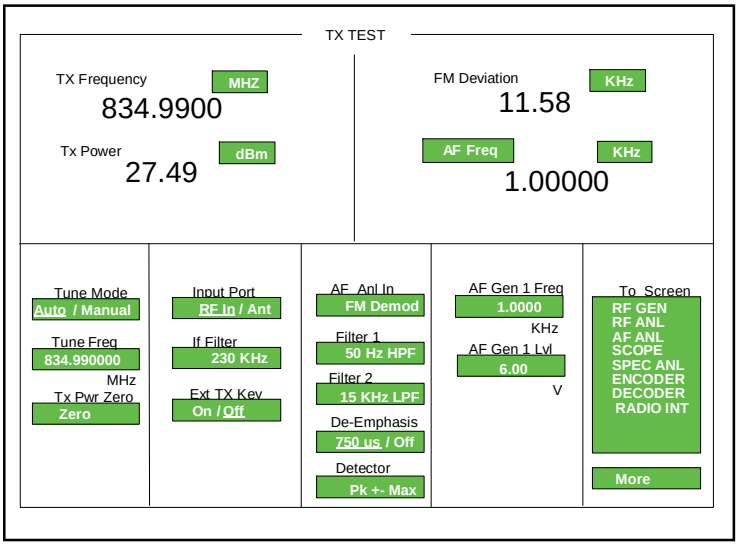
The frequency error measured on the communications analyzer must be less than ±1 kHz.

Communications Analyzer Setup:

- **Select** TX **button from the Screen Control panel**
- **PWR** is measured in **dBm**
- Set **Frequency Measurement** to **auto or manual** (display will show TX Freq. Error)
- Set **TX frequency** to **834.990 MHz**
- Set **IF filter** to **230 kHz**
- Set **AF Filter 1** to **50 Hz**
- Set **AF Filter 2** to **15 kHz**
- Set **AF gen1** for **1 kHz frequency** at **6V level** (output will go to the **audio** port)

TX Maximum Deviation Test

Figure 28. TX Test Screen



Test Mode Commands:

11333#	Load synthesizer to channel 333
122#	Set power level to power step 2
05#	Turn on transmit carrier
356#	Select External TX Audio path
10#	Unmute TX Audio path
58#	Turn on compandor

View FM Deviation for reading.

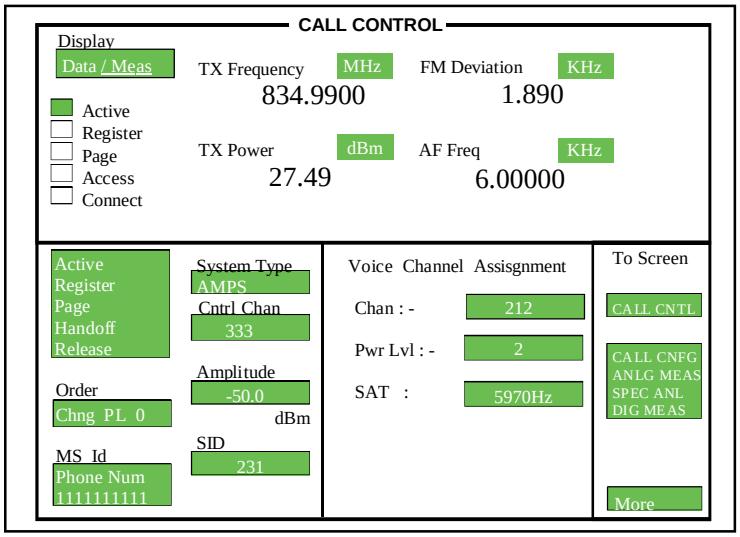
TX Maximum Deviation Pass Specifications: 9.8 kHz - 12 kHz.

Communications Analyzer Setup:

- **Select** TX **button from the Screen Control panel**
- **PWR** is measured in **dBm**
- Set **Frequency Measurement** to **auto or manual** (display will show TX Freq. Error)
- Set **TX frequency** to **834.990 MHz**
- Set **IF filter** to **230 kHz**
- Set **AF Filter 1** to **50 Hz**
- Set **AF Filter 2** to **15 kHz**
- Set **AF gen1** for **1 kHz frequency** at **6V level** (output will go to the **audio** port)

TX SAT Deviation Test

Figure 29. Call Control Screen



Select CALL CNTL from the To Screen

- Select System type: **AMPS**
- Zero the RF Power meter in the: **Call Config Screen**
- Set Amplitude to: **-50 dBm**
- Set SID: **Your phone's System ID**
- Select: **Active**
- **Voice Channel Assignment Type:**
- Chan: **212**
- Pwr Lvl: **4**
- SAT: **5970Hz**

Procedure

1 Dial the desired phone number on the mobile station and press SEND.

2 The Access annunciator will light while the Test Set signals the mobile on the assigned voice channel.

3 The connect annunciator will light if the mobile properly signals the Test Set.

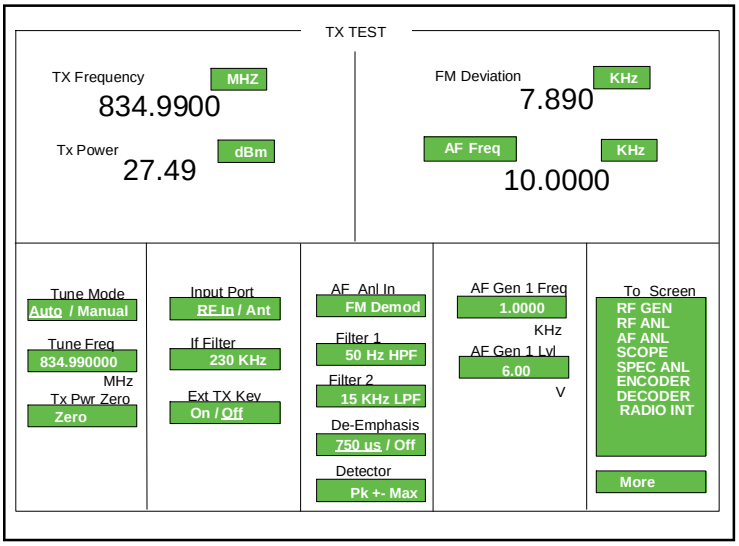
View FM Deviation for the reading.

The transponded peak SAT FM deviation should be 2 kHz ±200 Hz.

The demodulated signal on the communications analyzer should have an audio frequency of 6000 Hz.

TX ST Deviation Test

Figure 30. TX Test Screen



Test Mode Commands:

11333#	Load synthesizer to channel 333
122#	Set power level to power step 2
05#	Turn on transmit carrier
14#	Enable signaling tone

View FM Deviation for reading.

The peak ST deviation measured on the communications analyzer should be 8 kHz ±800 Hz deviation.

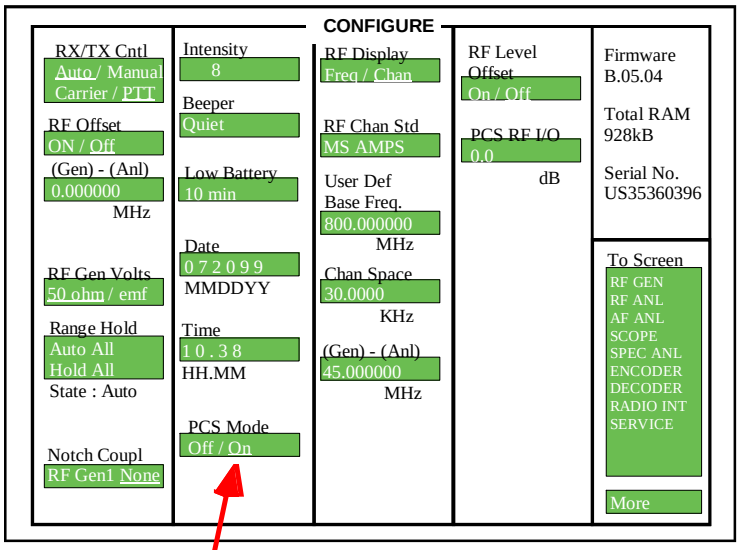
The demodulated signal on the communications analyzer should have an audio frequency of 10 kHz.

Communications Analyzer Setup:

- Select **TX** button from the Screen Control panel
- **PWR** is measured in **dBm**
- Set **Frequency Measurement** to **auto or manual** (display will show TX Freq. Error)
- Set **TX frequency** to **834.990 MHz**
- Set **IF filter** to **230 kHz**
- Set **AF Filter 1** to **50 Hz**
- Set **AF Filter 2** to **15 kHz**
- Set **AF gen1** for **1 kHz frequency** at **6V level** (output will go to the **audio** port)

Setting up for PCS TDMA Measurements

Figure 31. Configure Screen

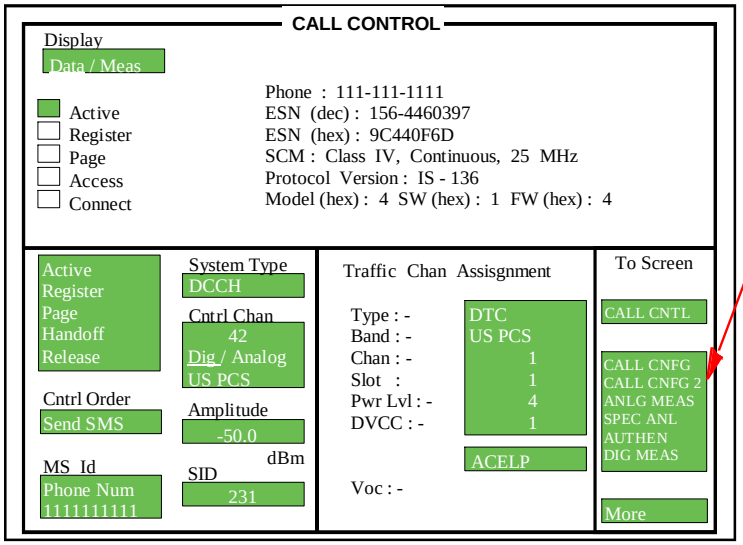


Set PC Mode to "On"

Power up the PCS Adapter, after two beeps are heard power up the 8920B

1 Go to the Configure screen on the 8920B (press blue shift key and then the Config/Duplex key).
2 Turn PCS mode to On.
3 Go to the Call Cntrl Screen by select ing More and then Call Cntrl from list.

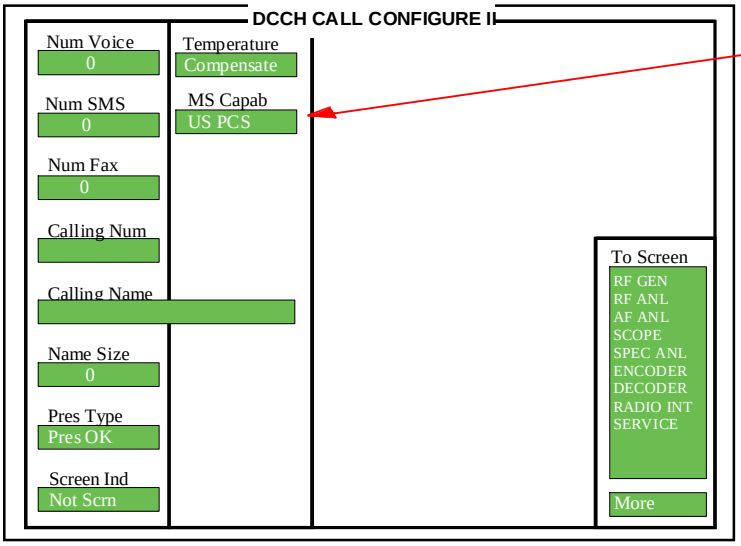
Figure 32. Call Control Screen



4 Select Call Config 2 Screen.
5 In the MS Capab field select select US PCS

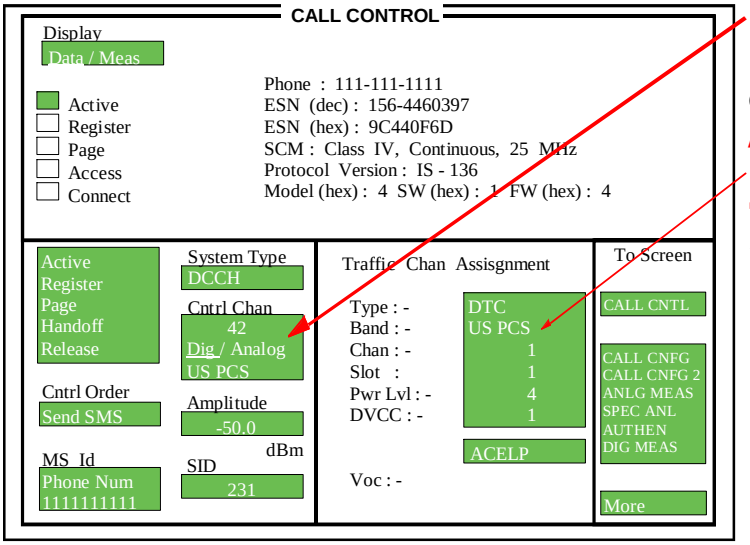
Setting up for PCS TDMA Measurements

Figure 33. DCCH Call Configure II Screen



5 In the MS Capab field select select US PCS

Figure 34. Call Control Screen

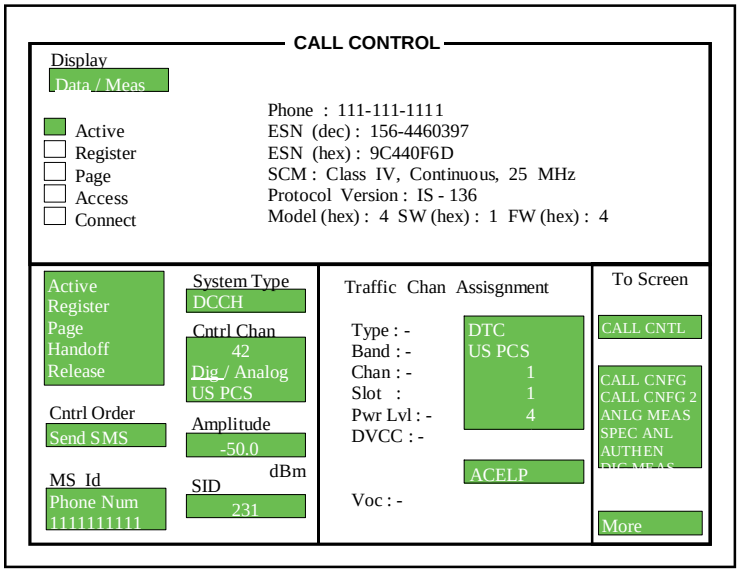


6 On the **Call Cntrl** Screen under the **Cntrl Chan** section select a digital control channel and select **US PCS** in the **Cellular / PCS** field.

7 On the **Call Cntrl** Screen under the **Traffic Channel Assignment** section in the **Band** field select US PCS.

Set up for TDMA call

Figure 35. Call Control Screen



Call Process

The following 4 steps need to be performed prior to beginning registration test:

1. Enter Test Mode using **FNC 0, 0, *, *, T, E, S, T, M, O, D, E, STO.**
2. Perform a 51# command in Test Mode to clear the Historic List. Turn off the telephone.
3. Connect the RF connector to the radio and power on.

Registration

1. Put the Test Set in Active state by selecting **Active** from the list on the left side of the screen.
2. Select **Data** from the **Data/Meas** field. This is the default mode.
3. Select **Register** from the list to register phone.
4. If the registration message has been received, the Test Set will display registration data in the upper half of the screen as shown in the sample screen above.

Select CALL CNTL from the To Screen

- Select System type: **DCCH**
- Zero the RF Power meter in the: **Call Config Screen**
- Set Amplitude to: **-50 dBm**
- Set SID: **Your phone's System ID**
- Select: **Active**
- **Traffic Channel Assignment Type:**
- Choose **DTC** to set up a Digital Traffic channel
- Type: **DTC**
- Chan: **1**
- Slot: **1**
- Pwr Lvl: **4**
- DVCC: **1**

Page

1 Select page from the list on the left side of the screen.

2 If the mobile responds, you will see the Access annunciator light briefly.

3 Answer the call by raising the flip or press SEND on the mobile to start the conversation.

4 The Connect annunciator lights. This is the Connect state. Data to be displayed is shown above.

Origination

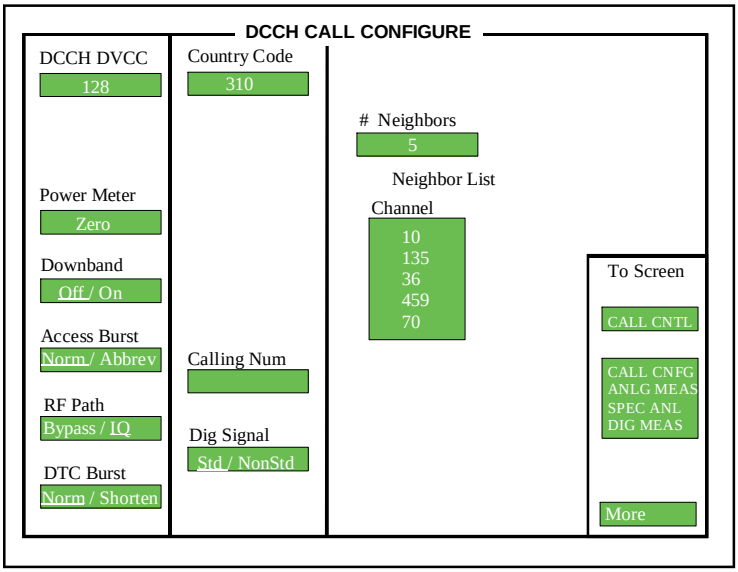
1 Dial the desired phone number on the mobile station and press SEND.

2 The Access annunciator will light while the Test Set signals the mobile on the assigned voice channel.

3 The connect annunciator will light if the mobile properly signals the Test Set.

MAHO Measurements

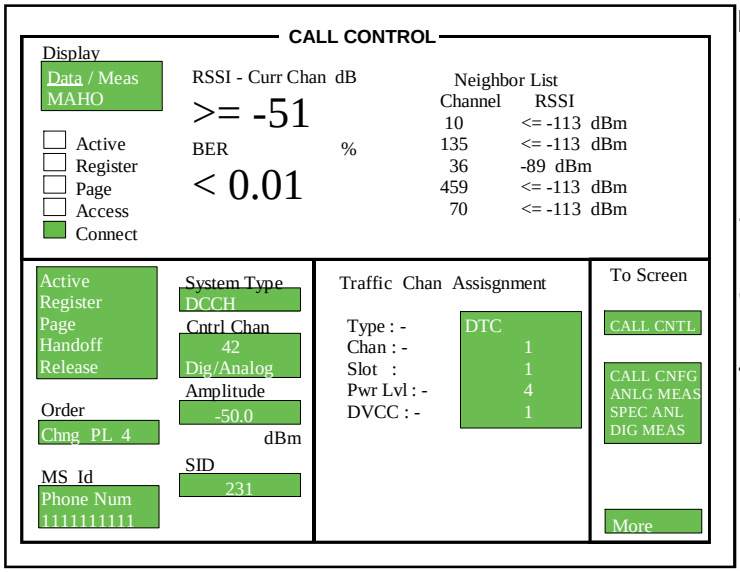
Figure 36. DCCH Call Configure Screen



Setting up the MAHO measurement

1 Select **CALL CNFG** from the CALL CONTROL's **To Screen.**
2 Set the number of neighbors (up to 6) with the field # Neighbors.
3 **Neighbor List Channel** fields ap pear below the **# Neighbors** field.
4 Set the channel number of each neigh bor channel.

Figure 37. Call Control Screen



Measuring MAHO

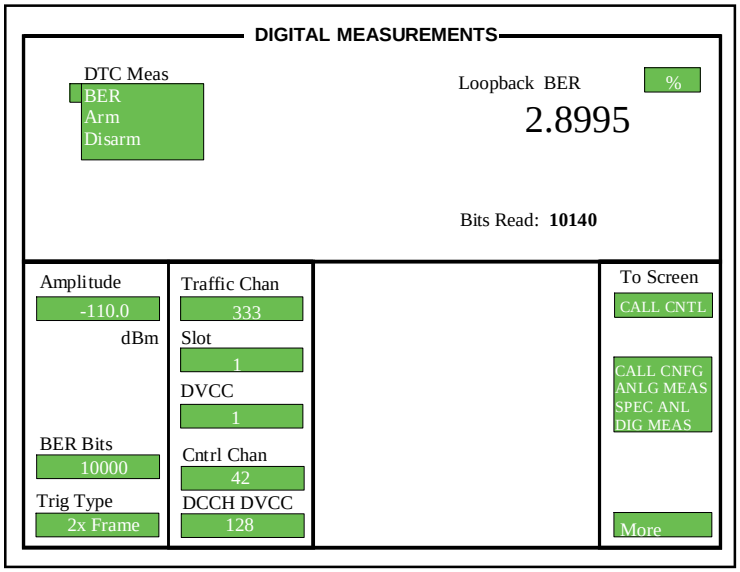
1 From **CALL CONTROL** screen, set up a call (Test Set must be in Connect mode).
2 Select **Meas** from the **Data / Meas** field.
3 Select the field that has appeared be low **Data / Meas.**
4 Select **MAHO** from the list of choices.
5 The **RSSI** and **BER** of the current channel are reported, as well as the **RSSI** of the designated neighbor chan nels.

MAHO (Mobile Assisted HandOff) is actually a measurement, not a handoff. The reported results are used by a base station to select the channel for the handoff.

The mobile performs the measurements, and them reports the results back to the base station. The mobile measures the **RSSI** of neighboring channels, as instructed by the base station. It also measures and reports the **RSSI** and **BER** of the current channel.

BER Measurements

Figure 37. Digital Measurements Screen



PCS Mode Handset Commands:

1 Enter 576# (Loopback mode)
2 11333# (Loads Synthesizer Channel)
3 Display prompt "Y" (enter desired time slot, for this test enter 1)
4 Display prompt "Y" (enter band, 0 = 800, 1 = 1900)
5 Set power level to step 2 (122#)
6 Turn on transmitt carrier (05#)

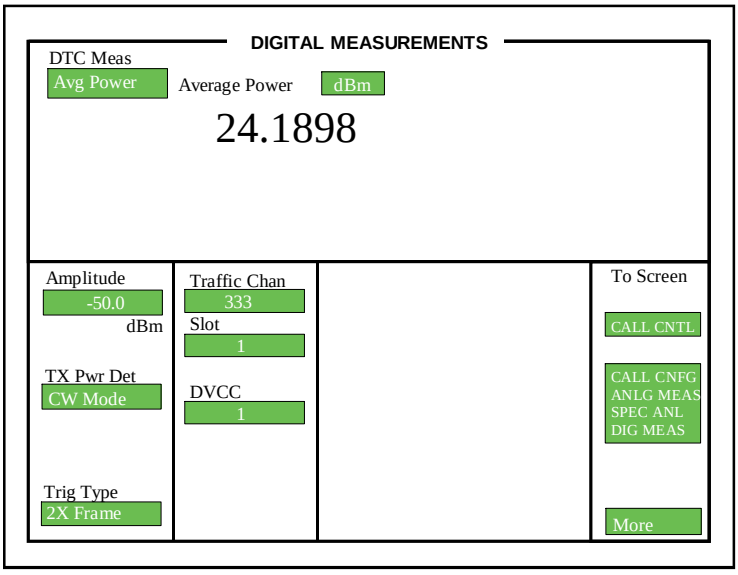
The BER measured on the communications analyzer must be less than or equal to **3%**.

BER Measurement Procedure

1 Make sure the Test Set is in Active mode.
2 Select **DIG MEAS** from the **To Screen** menu.
3 Select the **DTC Meas** field to display a list of available tests.
4 Select **BER** from the list.
5 Enter the number of bits to be measured in the **BER Bits** field. (Note: the number of bits actually read will be calculated in whole frames.)
6 **Amplitude** should be set to -110 dBm.
7 **Traffic Chan** to 333.
8 **Slot** to 1.
9 **DVCC** to 1.
10 **Cntrl Chan** to 42.
11 **DCCH DVCC** to 128.
12 Put the mobile into test mode and enter the proper test commands for **BER** reading.
13 Select **ARM**.
14 After the actual number of bits has been transmitted and received, the **BER** should be displayed.

TX Power Measurements

Figure 38. Digital Measurements Screen



Digital TX Power Out Test Procedure

1 Make sure the Test Set is in Active mode.
2 Select **DIG MEAS** from the **To Screen**.
3 Select the **DTC Meas** field. This shows the **To Screen** with a list of available tests.
4 Select **AVG Power.**
5 **Traffic Chan** should be set to 333.
6 Put the mobile into test mode.
7 Make Digital TX Power Out measure ments.

PCS Mode Handset Commands:

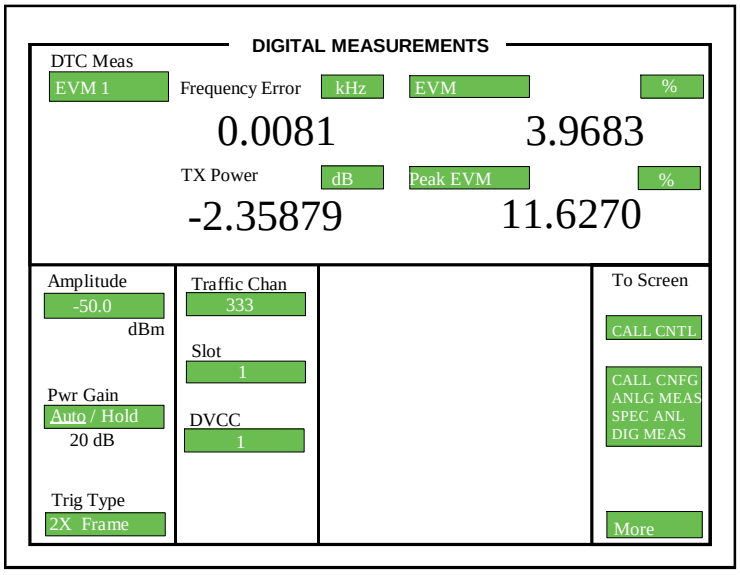
1 Enter 575# (Digital signaling mode)
2 11333# (Loads synthesizer Channel)
3 Display prompt "Y"(enter time slot)
4 Display prompt "Y"(enter band, 0 = 800, 1 = 1900)
5 Set power level to step 2 (122#)
6 Turn on transmitt carrier (05#)

Max Digital TX power out should be around **26 dB** minus cable loss.

You can also use Digital Call processing to make these measurements.

TX Frequency Error Measurements

Figure 39. Digital Measurements Screen



TX Frequency Error Measurement Test

1 Make sure the Test Set is in Active mode.
2 Select **DIG MEAS** from the **To Screen**.
3 Select the **DTC Meas** field. This shows the **To Screen** with a list of available tests.
4 Select **EVM 1**.
5 **Traffic Chan** should be set to 333.
6 Put the mobile into test mode.
7 Frequency error is displayed.

PCS Mode Handset Commands:

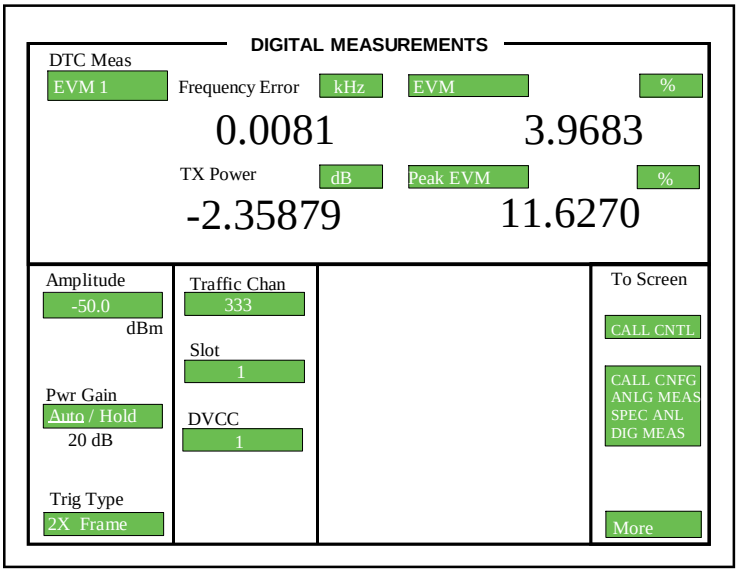
1 Enter 575# (Digital signaling mode)
2 11333# (Loads synthesizer Channel)
3 Display prompt "Y" (enter time slot)
4 Display prompt "Y" (enter band, 0 = 800, 1 = 1900)
5 Set power level to step 2 (122#)
6 Turn on transmitt carrier (05#)

The frequency error measured on the communications analyzer must be **<200Hz**.

You can also use Digital Call processing to make these measurements.

EVM Measurements

Figure 40. Digital Measurements Screen



TX Frequency Error Measurement Test

1 Make sure the Test Set is in Active mode.
2 Select **DIG MEAS** from the **To Screen**.
3 Select the **DTC Meas** field. This shows the **To Screen** with a list of available tests.
4 Select **EVM 1**. **EVM 10** can also be selected, it measures a 10 burst aver age.
5 **Traffic Chan** should be set to 333.
6 Put the mobile into test mode.
7 EVM is displayed.

PCS Mode Handset Commands:

1 Enter 575# (Digital signaling mode)
2 11333# (Loads synthesizer Channel)
3 Display prompt "Y" (enter time slot)
4 Display prompt "Y" (enter band, 0 = 800, 1 = 1900)
5 Set power level to step 2 (122#)
6 Turn on transmitt carrier (05#)

The 10 burst average EVM measured should be less than or equal to **12.5%**.

You can also use Digital Call processing to make these measurements.

Disassembly

Introduction

Some troubleshooting and maintenance procedures for cellular phones require disassembly of the phone to gain access to internal components. Reasonable care should be taken to avoid damaging or stressing the housing and internal components during disassembly and reassembly.

CAUTION

Many of the integrated circuit devices used in this equipment are vulnerable to damage from static charges. An anti-static wrist band, connected to an anti-static (conductive) work surface, must be worn during all phases of disassembly, repair, and reassembly.

Recommended Tools

The following tools are recommended for use during the disassembly and reassembly of the TDMA Modulus 3.

- Anti-Static Mat Kit (RPX-4307A); includes:
  - Anti-Static Mat
  - Ground Cord
  - Wrist Band
- T6 Torx driver

Telephone Disassembly

Antenna Removal

Use the thumb and index finger to remove the antenna using a counterclockwise twisting motion.

Battery Removal

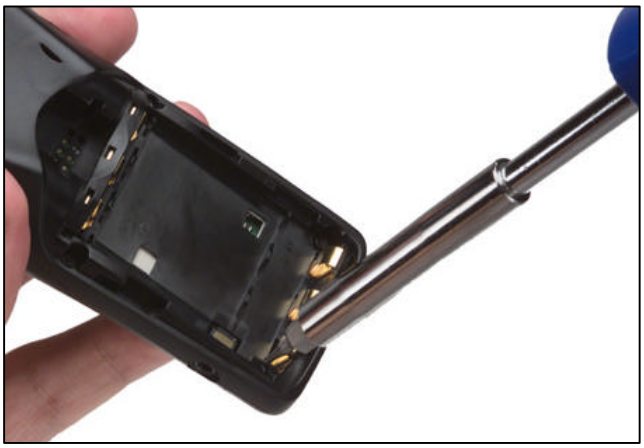
1. Turn off the telephone.
2. While holding the phone firmly with one hand, use the index finger on the other hand to press the latch on the battery cover.

3. Slide the cover back to release it from the phone.

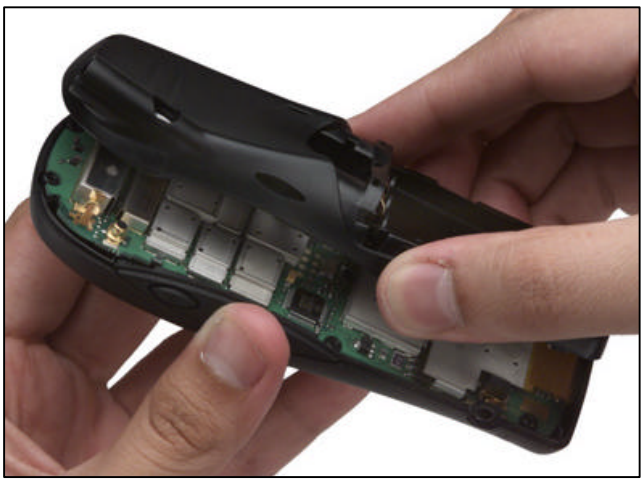
4.Use the thumb and index finger to grab the batteries and pull them out of the telephone housing.

Back Housing Removal

1.Using a T6 Torx driver, unscrew the five torx screws that attach the back housing to the main body of the phone.



2.Carefully lift the back housing and pull it off the main assembly.

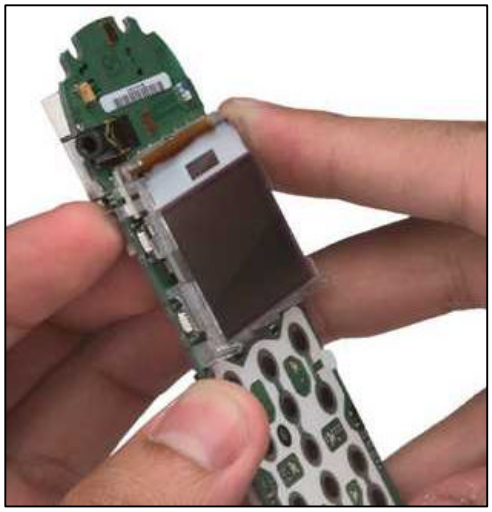


Transceiver Board Removal

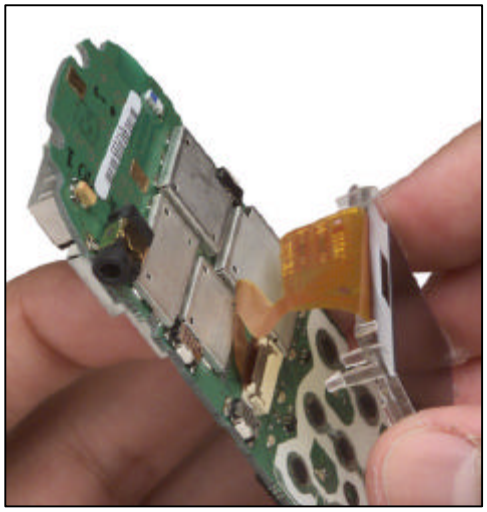
While holding the phone firmly with one hand, use the thumb, middle and index fingers of the other hand to carefully separate the transceiver phone from the main assembly.

Display Removal

1. Lift the latches that hold the display in place to separate the display from the main board.
.



2.Carefully separate the display from the main board, taking special care not to damage the flex assembly.



3.Using tweezers, lift the flex connector to release the flex assembly from the main board. Carefully lift the display from the main board.

Keypad Removal

Lift the keypad from the front housing using the thumb and index fingers.

Speaker Removal

Carefully pry off the speaker from the front housing using tweezers.

Parts List

Introduction

Motorola maintains a parts office staffed to process parts orders, identify part numbers, and otherwise assist in the maintenance and repair of Motorola Cellular products. Orders for all parts listed in this document should be directed to the following Motorola International Logistics Department:

Accessories and Aftermarket (AAD)
Schaumburg, IL, USA

Domestic
Customer Service: 1-800-422-4210
Hours: 7am - 7pm US Central Time

International
Customer Service: 1-847-538-8023
Hours: 8am - 6:30pm US Central Time

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it.

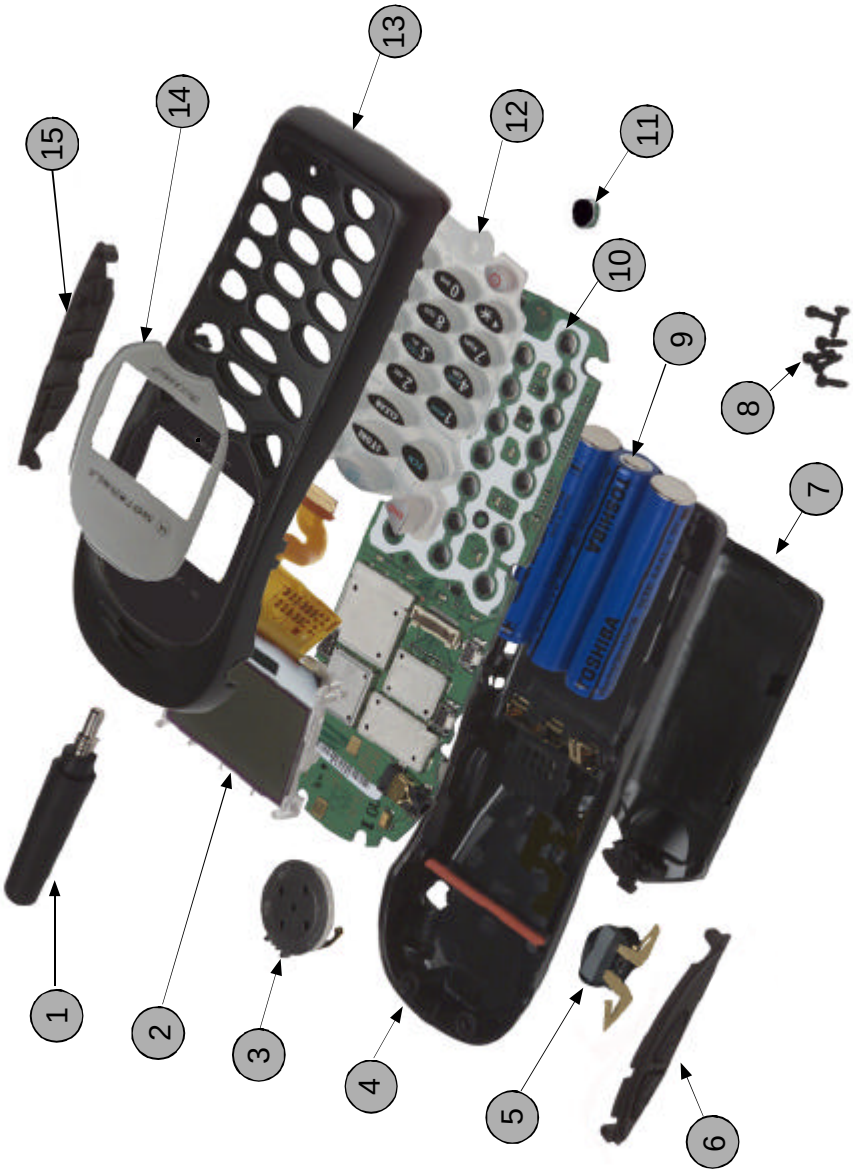
Mechanical Explosion

The Mechanical explosion contains a table of mechanical part numbers that may change after publication of this manual. For an updated list of part numbers contact an AAD representative at the numbers listed above.

Electrical Parts

The eletrical parts list provided in this manual contains Motorola part numbers to all the electrical components that exist in the phone. The list is arranged in alphabetical order by reference designator.

AAD will have available the most common electrical components in their warehouse. Electrical components like resistors and capacitors are not normally available in AAD's warehouse. If service centers require the purchase of components that are not available AAD's warehouse, call the AAD customer service line and place a request to have the component available. If there is a high demand for a particular component, AAD will make the components available for purchase.



1	ANTENNA	8588448K01	6	GRIP LEFT	3285837K01	11	MIC.	5009135L07
2	DISPLAY	7288454K02	7	DOOR BATTERY	SHN7282A	12	KEYPAD	3885839K02
3	SPEAKER	5009076E25	8	SCREW	0309315B07	13	FRT. HOUSING	1585830K01
4	REAR HOUSING	1585832K01	9	BATTERY	SNN5542A	14	LENS	6185840K04
5	ALERT	5009005J07	10	MYLAR	4085941K01	15	GRIP RIGHT	3285838K03

Figure 39. Mechanical Explosion

Reference Designator	Part Number
A100	39-89033K01
C1	21-13743N26
C10	21-13743N69
C100	21-13743N22
C1000	21-13743M24
C1001	21-13741F49
C1002	21-13743E20
C1003	21-13743E20
C1004	21-13743M24
C1005	21-13743M24
C1006	21-13743M24
C1012	21-13743E20
C1021	21-13928P04
C1022	21-13743M24
C1023	21-13743M24
C108	21-13743L17
C109	21-13743A23
C1093	21-13743M24
C11	21-13743N19
C111	21-13743L17
C112	21-13743N40
C113	21-13743L05
C12	21-13743N14
C1200	21-13928P04
C121	21-13743N30
C122	21-13743N30
C124	21-13743E07
C125	21-13743L01
C126	21-13743L05
C127	21-13743L11
C128	21-13743L17
C129	21-13741A59
C13	21-13743N40
C131	21-13741F39
C132	21-13743E20
C133	21-13743N50
C134	21-13743L41
C135	21-13743N26
C14	21-13743L17
C15	21-13743N34
C150	21-13743L41
C1501	21-13928G01
C1502	21-13743N24
C1503	21-13743N24
C1505	21-13928K09
C1506	21-13928K09
C1507	21-13743E20
C1508	21-13928K09
C1509	23-11049A62
C151	21-13743N40
C1510	21-13743N40
C1511	21-13743N40
C1512	21-13743L17
C1513	21-13743L05
C1514	21-13743N50
C1515	21-13743E20
C1516	21-13928N01
C1518	23-11049A89
C1519	21-13743L01
C152	21-13743N35
C1520	21-13743L01
C1521	21-13743N40
C1522	21-13743N40
C1523	21-13743N40
C153	21-13743N37
C1530	21-13928K09
C1531	21-13928K09
C1535	21-13743N40
C1536	21-13743N40
C1537	21-13928N01
C1538	21-13743L11
C1539	21-13743N40
C1540	21-13743N40
C1541	21-13928N01
C1542	21-13743E20
C1544	21-13743N40
C1545	21-13928N01
C1546	21-13743N26
C155	21-13743N50
C1550	21-13743E20
C1551	21-13743E20
C1552	23-11049A62
C1553	23-11049A62
C1562	21-13928L05
C1563	23-11049A65
C1564	21-13743L41
C1570	21-13928N01
C1571	21-13743N40
C1572	21-13743N40
C1573	21-13743N40
C1574	21-13743N40
C1575	21-13743N40
C1576	21-13743N40
C1577	21-13743N40
C1578	21-13743N40
C1579	21-13743N40
C1580	21-13743N40
C1581	21-13743E20
C1582	21-13743N40
C1583	21-13743N40
C1584	21-13743N40
C1585	21-13743N40
C1587	21-13743N26
C1588	21-13743N26
C1589	21-13743G26
C1590	21-13743F18
C1591	21-13743N24
C1592	21-13743E20
C1593	21-13743N24
C1594	21-13743N24
C1595	21-13743N24
C1596	21-13743N24
C1597	21-13743N24
C1598	21-13743N28
C16	21-13743N40
C1700	21-13743M24
C1701	21-13743M24
C1702	21-13743M24
C1800	21-13743L41
C1801	21-13743E07
C1802	21-13743L25
C1803	21-13743N50
C1804	21-13743L41
C1805	21-13743L41
C1806	21-13743N16
C1807	21-13743E20
C1808	21-13743E20
C1809	21-13743E20
C1810	21-13743E20
C1811	21-13743A23
C1812	21-13743L41
C1813	21-13743E20
C1814	21-13743L41
C1815	21-13743L17
C1816	21-13743L41
C1817	21-13743L01
C18853	21-13743N50
C18860	21-13743N40

Reference Designator	Part Number
C18862	23-11049A62
C18871	21-13743L41
C18873	21-13743N30
C18881	21-13743L17
C18885	21-13743N40
C18886	21-13743N40
C18887	21-13743N40
C18889	21-13743N40
C18900	21-13740F27
C18901	21-13740F27
C18902	23-11049A86
C18903	21-13928L05
C18908	21-13928N01
C18910	21-13743N26
C18911	21-13743N26
C18912	21-13743B29
C18913	21-13743N40
C18914	23-11049A86
C18915	23-11049A86
C1900	21-13743G26
C1902	21-13743M24
C1903	21-13743M24
C1904	21-13743M24
C1905	21-13743M24
C1906	21-13743M24
C1910	21-13743G26
C1911	21-13743N50
C2	21-13743L17
C20	21-13743N20
C202	21-13743N40
C203	21-13743N40
C204	21-13743L41
C205	21-13743N40
C21	21-04801Z18
C23	21-04801Z12
C24	21-13743N40
C25	21-13743L17
C251	21-13928C03
C252	21-13743F16
C253	21-13743L41
C26	21-13743L17
C261	21-13743L41
C262	21-13743F16
C263	21-13743L41
C272	21-13743L27
C273	21-13743L41

Reference Designator	Part Number
C274	21-13743L41
C3	21-13743N40
C30	21-13743N03
C300	21-13743N40
C302	21-13743L17
C303	23-11049A40
C304	21-13743N50
C305	21-13743L17
C306	21-13743E20
C307	21-13743N09
C308	21-13743L17
C309	21-13743L01
C310	21-13743L01
C311	21-13743N33
C312	21-13743N33
C313	21-13743L27
C315	21-13741A61
C316	21-13743N50
C317	21-13743L27
C32	21-13743N69
C33	21-13743N18
C333	21-13743N67
C334	21-13743L41
C335	21-13743N40
C339	21-13743N40
C34	21-13743L25
C342	21-13743N40
C343	21-13743N40
C35	21-13743N30
C350	21-13743N40
C351	21-13743N03
C36	21-13743N22
C37	21-13743N40
C38	21-13743N05
C389	21-13743N30
C395	21-13743L17
C399	21-13743L17
C4	21-13743L17
C400	21-13743N40
C401	21-13743N40
C402	21-13743L41
C404	21-13743N40
C405	21-13743N24
C406	21-13743N40
C407	21-13743N28
C410	21-13743N05

Reference Designator	Part Number
C411	21-13743N26
C412	21-13743N26
C413	21-13743N28
C414	21-13743N05
C425	21-13743N40
C426	21-13743L41
C427	21-13743L17
C447	21-13743N26
C452	21-13743N20
C454	21-13743L17
C455	21-13928N01
C487	21-13743N40
C499	21-13743N67
C5	21-13743N02
C501	21-13743N28
C502	21-13743L41
C503	21-13743N28
C504	21-13743L41
C505	21-13743L41
C506	21-13743N28
C508	21-13743N40
C509	21-13743N40
C51	21-13743N40
C510	21-13743N09
C511	21-04801Z14
C512	21-13743N28
C513	21-13743N28
C515	21-13743N05
C516	21-13743N16
C517	21-13743N09
C52	21-13743N40
C53	21-13743N18
C54	21-13743N16
C550	21-13743N12
C552	21-13743N02
C628	21-13743N23
C711	21-13743N22
C772	21-13743N30
C800	21-13743N40
C801	21-13743N40
C802	21-13743N27
C803	21-13743N17
C804	21-13743N40
C805	21-13743N24
C806	21-13743N23
C807	21-13743N16

Reference Designator	Part Number
C808	21-13743N40
C811	21-13743N11
C814	21-13743N69
C815	21-13743N15
C820	21-13743N40
C821	21-13743M24
C822	21-13743N40
C823	21-13743N15
C824	21-13743N69
C825	21-13743N40
C826	21-13743N40
C827	21-13743L17
C828	21-13743N40
C829	23-03770S08
C830	21-13743N26
C831	21-13743N40
C882	21-13741F41
C883	21-13741F25
C884	21-13741A45
C885	21-13740F67
C886	21-13741A61
C887	21-13741F25
C888	21-13743N40
C898	21-13743L41
C899	21-13743N40
C902	21-04801Z16
C903	21-04801Z20
C904	21-13743N24
C905	21-13743M24
C906	21-13743N24
C907	21-13743N24
C911	21-04801Z13
C912	21-04801Z11
C913	21-13743N12
C914	21-04801Z12
C962	23-11049A86
C963	23-11049A86
C9910	21-13743N40
C998	21-13928N01
CR100	48-09877C08
CR1001	48-09606E07
CR1540	48-09924D09
CR1562	48-09653F07
CR1563	48-09606E02
CR1590	48-09924D09
CR1597	48-09948D33

Reference Designator	Part Number
CR1598	48-09948D33
CR1599	48-09948D33
CR300	48-09877C08
CR301	48-09877C08
CR302	48-09948D13
CR501	48-09948D33
CR502	48-09948D33
CR503	48-09948D12
CR504	48-09948D33
CR730	48-09606E02
CR810	48-09606E02
CR822	48-09948D12
CR823	48-09948D12
CR910	48-09606E02
DS901	48-09496B11
DS902	48-09496B11
DS903	48-09496B11
DS904	48-09496B11
DS905	48-09496B11
DS906	48-09496B11
DS907	48-09496B11
DS908	48-09496B11
DS909	48-09496B11
DS910	48-09496B11
DS911	48-09496B11
DS912	48-09496B11
DS913	48-09496B11
F500	91-09381T01
FL10	91-03913K04
FL100	91-62928D01
FL20	91-03917K04
FL30	91-85861J02
FL350	91-03913K06
FL413	91-85623G02
FL452	91-03913K03
FL453	91-85911J05
FL454	91-03913K03
J1	09-85882K01
J100	09-87378K01
J900	09-09195E01
J902	09-09059E01
J940	09-85839G03
J941	39-09301S02
J942	39-09301S02
L101	24-04574Z11
L11	24-09154M62

Reference Designator	Part Number
L12	24-09154M61
L150	24-62587Q53
L1550	24-09154M68
L1593	24-09154M71
L1594	24-09154M71
L1599	24-09154M71
L20	24-13926K25
L21	24-13926K23
L23	24-13926K27
L30	24-09154M56
L302	24-09414M17
L303	24-09414M12
L31	24-09154M56
L351	24-62587V33
L361	24-09154M65
L378	24-09154M65
L40	24-09154M54
L400	24-09154M57
L401	24-09154M63
L403	24-09154M51
L404	24-09646M22
L405	24-09646M98
L406	24-09154M60
L407	24-09154M58
L451	24-09154M68
L452	24-09154M68
L502	24-09154M55
L503	24-09154M60
L504	24-09154M62
L505	24-09154M63
L550	24-09154M57
L552	24-09154M55
L553	24-09154M51
L555	24-13926M14
L800	24-09348J08
L802	24-09154M62
L803	24-09154M63
L804	24-09154M63
L820	24-09646M22
L821	24-09646M22
L907	24-09154M71
L962	24-09414M09
L967	24-09154M71
L968	24-09154M61
L969	24-09646M05
Q1099	48-82033T02

Reference Designator	Part Number
Q1501	48-09579E42
Q151	48-09579E24
Q152	48-09605E02
Q1551	48-09607E05
Q1574	48-09579E40
Q1597	48-09939C06
Q1598	48-09607E02
Q1802	48-09579E02
Q1803	48-09579E02
Q1804	48-09579E02
Q1805	48-09579E02
Q1806	48-09579E24
Q1807	48-09807C32
Q1809	48-09605E02
Q1810	48-09605E05
Q1811	48-09605E02
Q1812	48-09807C37
Q301	48-09579E02
Q351	48-09579E43
Q391	48-09527E24
Q401	48-09527E22
Q411	48-87716K01
Q475	48-09579E42
Q501	48-09607E05
Q502	48-09527E18
Q503	48-09579E30
Q505	48-09579E02
Q810	48-09579E24
Q811	48-09579E24
Q820	48-09607E05
Q821	48-09607E05
Q880	48-09579E30
Q901	48-09807C32
Q910	48-09579E24
Q962	48-13824B11
R1000	06-62057N03
R10013	06-62057N06
R10014	06-62057M98
R10016	06-62057M98
R10017	06-62057M98
R10018	06-62057M38
R10021	06-62057M98
R10023	06-60076N36
R10024	06-62057M73
R1005	06-62057M98
R1009	06-62057M26

Reference Designator	Part Number
R10095	06-62057M36
R10096	06-62057M36
R1010	06-62057N01
R10100	06-62057M90
R10101	06-62057M74
R10102	06-62057M74
R10103	06-62057M74
R10104	06-62057M74
R10105	06-62057M74
R10106	06-62057M74
R10107	06-62057M74
R10108	06-62057M74
R10109	06-62057M74
R1011	06-62057N03
R10110	06-62057M74
R10115	06-62057M98
R10117	06-62057M01
R1012	06-62057M74
R10120	06-62057M01
R10124	06-62057N23
R10127	06-62057N09
R10129	06-62057M67
R1013	06-62057M74
R10130	06-62057M74
R10131	06-62057N17
R10132	06-62057M66
R10133	06-62057M58
R10134	06-11079A20
R10136	06-62057N23
R1014	06-62057N23
R1030	06-62057N09
R1031	06-62057N15
R1032	06-62057N15
R1036	06-62057M84
R1050	06-62057N15
R1088	06-62057M74
R1089	06-62057N23
R1090	06-62057M01
R1092	06-62057N15
R1097	06-62057N15
R1098	06-62057N03
R1099	06-62057N01
R1100	06-62057M38
R1101	06-62057M38
R1102	06-62057M38
R1103	06-62057M38

Reference Designator	Part Number
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R1105	06-62057M38
R1106	06-62057M38
R1107	06-62057M38
R1108	06-62057M38
R1109	06-62057M38
R1110	06-62057M38
R1111	06-62057M38
R1112	06-62057M38
R1200	06-62057M90
R1201	06-62057M98
R1203	06-62057M98
R1204	06-62057N23
R1205	06-62057M74
R121	06-62057M98
R122	06-62057M90
R131	06-62057M74
R151	06-62057N03
R1512	06-62057M01
R1513	06-62057M01
R1514	06-62057M01
R1515	06-62057M98
R1516	06-62057N15
R152	06-62057N15
R1521	06-62057N31
R1522	06-62057N25
R1523	06-62057M82
R1524	06-62057M98
R153	06-62057N09
R1532	06-62057N25
R1533	06-62057N31
R1534	06-62057M90
R1536	06-62057M54
R1537	06-62057M98
R154	06-62057M67
R1540	06-62057N15
R1553	06-62057M98
R1554	06-62057N13
R1555	06-62057M01
R1561	06-62057M92
R1573	06-60076N49
R1574	06-62057N23
R1575	06-62057N47
R1580	06-62057M98
R1581	06-62057M82
R1592	06-62057M98

Reference Designator	Part Number
R1593	06-09591M45
R1594	06-62057N39
R1596	06-62057N39
R1597	06-62057M98
R1598	06-62057M98
R1700	06-62057N33
R1800	06-62057N11
R1801	06-62057M01
R1804	06-62057M82
R1806	06-62057N16
R1810	06-62057N17
R1811	06-62057N17
R1820	06-62057N23
R1830	06-62057N15
R1900	06-62057M26
R1901	06-62057M01
R1910	06-62057M90
R1911	06-62057N11
R1912	06-62057N11
R1913	06-62057N15
R201	06-62057M43
R3	06-62057M37
R30	06-62057M65
R301	06-62057M72
R302	06-62057N17
R303	06-62057N01
R304	06-62057N13
R305	06-62057M81
R306	06-62057N06
R308	06-62057M54
R311	06-62057M43
R341	06-62057N13
R342	06-62057N07
R350	06-62057M68
R391	06-62057M96
R392	06-62057N03
R393	06-62057M64
R402	06-62057M98
R403	06-62057N13
R405	06-62057M34
R406	06-62057M85
R407	06-62057M52
R408	06-62057M40
R409	06-62057M85
R425	06-62057N13
R450	06-62057M50

Reference Designator	Part Number
R451	06-62057M43
R452	06-62057M74
R498	06-62057M98
R499	06-62057M98
R501	06-62057M38
R502	06-62057M98
R503	06-62057M90
R504	06-62057M90
R505	06-62057N11
R506	06-62057M76
R507	06-62057M62
R508	06-62057M38
R509	06-62057M62
R510	06-62057M50
R511	06-62057M56
R515	06-62057M46
R52	06-62057M43
R53	06-62057M43
R551	06-62057A40
R552	06-62057A40
R554	06-62057A05
R562	06-60076S01
R60	06-62057N09
R712	06-62057M01
R721	06-62057M74
R722	06-62057M74
R723	06-62057M74
R724	06-62057M74
R725	06-62057M74
R726	06-62057M74
R727	06-62057M74
R728	06-62057M74
R729	06-62057M74
R730	06-62057M90
R734	06-62057M74
R735	06-62057M74
R800	06-62057M36
R801	06-62057M26
R802	06-62057M95
R804	06-62057M61
R806	06-62057M78
R807	06-62057M43
R808	06-62057M26
R809	06-62057M26
R811	06-62057M76
R825	06-62057M36

Reference Designator	Part Number
R881	06-62057M92
R882	06-62057N03
R883	06-62057M92
R884	06-62057M85
R893	06-62057M94
R906	06-62057M80
R907	06-62057M80
R908	06-62057M73
R911	06-62057M66
R964	06-80195M64
R999	06-62057M20
RT1	06-87802K01
S508	40-09368L01
S512	40-09368L01
S525	40-09368L01
SH1	26-87601K01
SH10	26-87610K01
SH11	26-87963K01
SH2	26-87602K01
SH3	26-87603K01
SH4	26-87604K01
SH5	26-87605K01
SH6	26-87606K01
SH7	26-87607K01
SH8	26-87608K01
SH9	26-87609K01
U10	51-09944C39
U1000	51-09841C57
U110	51-09879E24
U1200	51-99404C01
U1300	51-09509A16
U150	48-09443R06
U1500	51-09879E42
U1501	51-09817F27
U1800	51-09817F34
U1900	51-99400C03
U1907	51-09962C16
U1908	51-99434A01
U301	51-09879E25
U306	48-09283D38
U801	51-09730C16
U901	51-09730C15
U903	51-09920D22
U960	51-09923D46
VR1500	48-09788E06
VR1551	48-09788E06

Reference Designator	Part Number
VR501	48-09788E06
VR502	48-09788E06
VR960	48-09788E06
XFMR37	58-85758J03
Y1500	48-09995L08

Reference Designator	Part Number

Reference Designator	Part Number

General Description

Antenna Circuit

Two RF ports are designed in this transceiver; internal antenna and external antenna. An RF switch controls which antenna path is going to be used during operation. Since this transceiver operates in two frequency bands(800MHz and 1900MHz), the switch also controls the RF frequency paths. Only one RF port and frequency band is used at a time, therefore, only one RF switch configuration is used while the other is irrevelent.

RX Front End

In 800MHz mode, the receive signal is mixed with the VCO and the result is the IF signal which is filtered prior to entering the ZIF/ SYN IC.

In 1900MHz mode, the VCO signal goes through a frequency doubler before getting mixed with the 1900MHz receive signal. This process allows the 1900MHz carrier frequency to be removed without the need of a second VCO.

NADC/PDC ZIF/SYN IC

The NADC/PDC ZIF/SYN is a 2.75 volt 81 pin BGA. It provides two fractional N phase locked loops for use with external VCOs. The transmit loop operates at 157.32 MHz in the cellular band and 192.36 MHz in the PCS band. The RX loop operates from 981-1006 MHz in the cellular band and from 1021-1051 MHz in the PSC band. The IC also provides regulator and superfilter functions for its synthesizer and the external VCOs. The IF portion of the IC operates with an input frequency of 112.32 MHz. The IC is linear up to the I and Q outputs of the baseband filters, can operate with internal or external AGC, and has a minimum dynamic range of -96.5 to -5.5 dBm. Both ZIF and SYN sections of the IC contain battery saving circuitry controlled by the SPI, and activated by an external pin.

TX Operational Description

For the 800 Mhz band, the TX carrier frequency is generated by mixing the main VCO signal with the offset VCO.In analog mode, the Offset VCO is modulated to provide FM.

In digital mode, the mixer output feeds an IQ modulator which is bypassed in analog mode.The signal passes through attenuators before being fed to the driver amplifier with bandpass filters and then it is sent to the 2 stage power amplifier. The Offset VCO, TX mixer, IQ modulator and amplifiers are contained within a custom integrated circuit.

The MerlinTX is a custom IC intended to provide IQ modulator, power control, and exciter functions for IS-136 TDMA portable cellular

phones. Both cellular and PCS bands are supported. The following functional blocks are contained in the IC:

- Feedback amplifier for offset synthesis
- Offset mixer for transmit generation
- Quadrature Modulator
- VCA for transmit power control
- Cellular PA and PCS PA
- Upconverter for PCS operation

For the 1900 Mhz band, the signal from the Offset VCO mixes with the main VCO to provide the TX IF.The signal,after passing through a series of attenuators, is filtered and mixed with the Main VCO signal to generate the 1900 TX carrier frequency.This signal goes throught the amplifying stages.The synthesizer consists of a ZIF/SYN IC that contains a reference divider, phase detector circuitry,prescaler,regulators and a charge pump as well as some circuitry for the Offset VCO.

The reference frequency source for the Main VCO is provided by a temperature controlled crystal oscillator.

In analog mode, DTMF, ST and SAT (among other things) are used to modulate the Offset VCO.In both 800 MHz and 1900 MHz digital modes, audio coming in from the microphone is filtered, digitized and structured into a TDMA time slot. A directional coupler and detector circuit at the output of the power amplifier provides a carrier power indicator to the logic unit, which then uses this value as feedback to set the voltageto the voltage controlled attenuator in an automatic power control loop.Power output is continually monitored.

The transmitter and receiver are duplexed with bandpass filters to a switch that feeds the signal to either the antenna connector or the external antenna jack.

Analog TX Audio Processing

The analog voice signal coming in through the microphone is taken by the CODEC and digitized.The samples produced by this step are then sent to the DSP.The following steps are realized with software implementation:

- Nominal TX Mic. Audio adjust amplifier
- Compressor -using a variable gain amplifier that controls the stage's gain by detecting the power at its output and applying the result to control the gain
- Deviation Limiter – using an amplifier in conjunction with a 7^{th} order odd polynomial with two output comparators. The polynomial reduces the amount of spectral splatter while the comparators switch as the signal reaches a high or low threshold.
- Audio mute
- Summing of all analog transmit modulation signals (Mic. Audio, Data/ST, DTMF and SAT)

A post-limiter splatter filter works with an up-shelf and a down-shelf filter to limit the maximum deviation of the transmitter.Data/ Signaling Tone is generated as a sinusoidal signal using a look-up table, which eases the filtering requirements for this signal because of the reduced harmonic energy it entails. DTMF is generated using look-up tables and SAT processing is also performed in the Transmit Audio Circuitry.

The D/A converts audio samples to an analog signal. This signal is then filtered and

applied to the Analog Mod. Input of the synthesizer circuit

Digital TX Audio Processing

The analog voice signal coming in through the microphone is taken by the CODEC and digitized. The samples are transmitted to the DSP where microphone compensation and echo cancellation processes take place. The DSP uses ACELP to compress the samples into data bits.These bits are interleaved with speech data from adjacent speech frames for error protection. System messages are then combined with the data bits and sent to the data converter for modulation. The data converter modulates the data using differential quadrature phase shift keying (DQPSK). The bit streams generated from this step are converted to analog signals which are filtered before being transmitted.

DSP Lucent 1629

Digital Signal Processor, 80 MIPS, 3 volt operation. It has a DPS1600 core with 16k words of internal dual-port RAM and 48k words of ROM. It is contained in a 169 ball µBGA package with the balls on a 13 x 13mm grid on 0.8mm centers.

Stuart IC

The STUART chip is a device intended for the following five functions.

- The HPI module provides a bus interconnection function, the host port, for the call processor (HC12) to talk to the DSP section via the call processor's parallel bus, interconnected to the DSP's parallel memory bus.
- The DSP Timer module provides a timer function controlled from DSP.
- The IO, test, 19.44MHz clock control, SPI, and CS switch module provides a 4-bits general-purpose I/O port, with programmable data direction, chip testing output pins muxed with IO pins, 19.44MHz clock control, SPI bus enable control, and special RAM chip select switch function. It also is used to generate a PWM output (PWM_OSC pin).
- The GP timer module is a general purpose timer. It is synchronous, 16 bits, count-down, preloadable, readable, and reloading on terminal count. It's input clock is 32.768KHz, which can be disabled, divided-by-2, or divided-by-4.
- The FIFO SOI Interface provides a 96 bit and a 16 bit buffer register accessible by either the DSP or HC12. The DSP controls who has write access to the data buffer and the SPI control register. Data is written in using 8 bit words and sent via the RF SPI as either a 96 bit or 16 bit write. The SPI clock speed is selectable as either 4.86MHz or 1.215MHz. The external SPI clock automatically stops after each write. The internal SPI clock can be disabled to save current. A maskable interrupts are available at the end of each SPI write.

GCAP II

GCAP II is intended to provide audio and power management functions for Motorola cellular telephone applications. GCAP II is composed of two die. The GCAP II contains the following functions:

- 2.775V linear regulator (V1)
- 5V linear regulator (VSIM)
- 2.775V linear regulator (V2)
- 2.775V linear regulator (V3)

- 2.775V low current reference (REF)
- Two BUCK/BOOST switching regulators
  - Switcher # 1 not used
  - Switcher # 2 BUCK mode 3.3V
- Charge Pump Output
- High End PA Regulator
- Differential Speaker (earpiece) amplifier
- Single ended Alert amplifier
- Single ended Auxiliary amplifier
- Turn on control signals to activate the radio
- Turn off control signals to turn off the radio if an error is detected
- Battery Charger
- SPI interface
- 10 channel 8 bit A/D
- 8 bit D/A
- Microphone amplifiers
- DSC bus buffers
- Audio CODEC with serial interface
- SPI interface

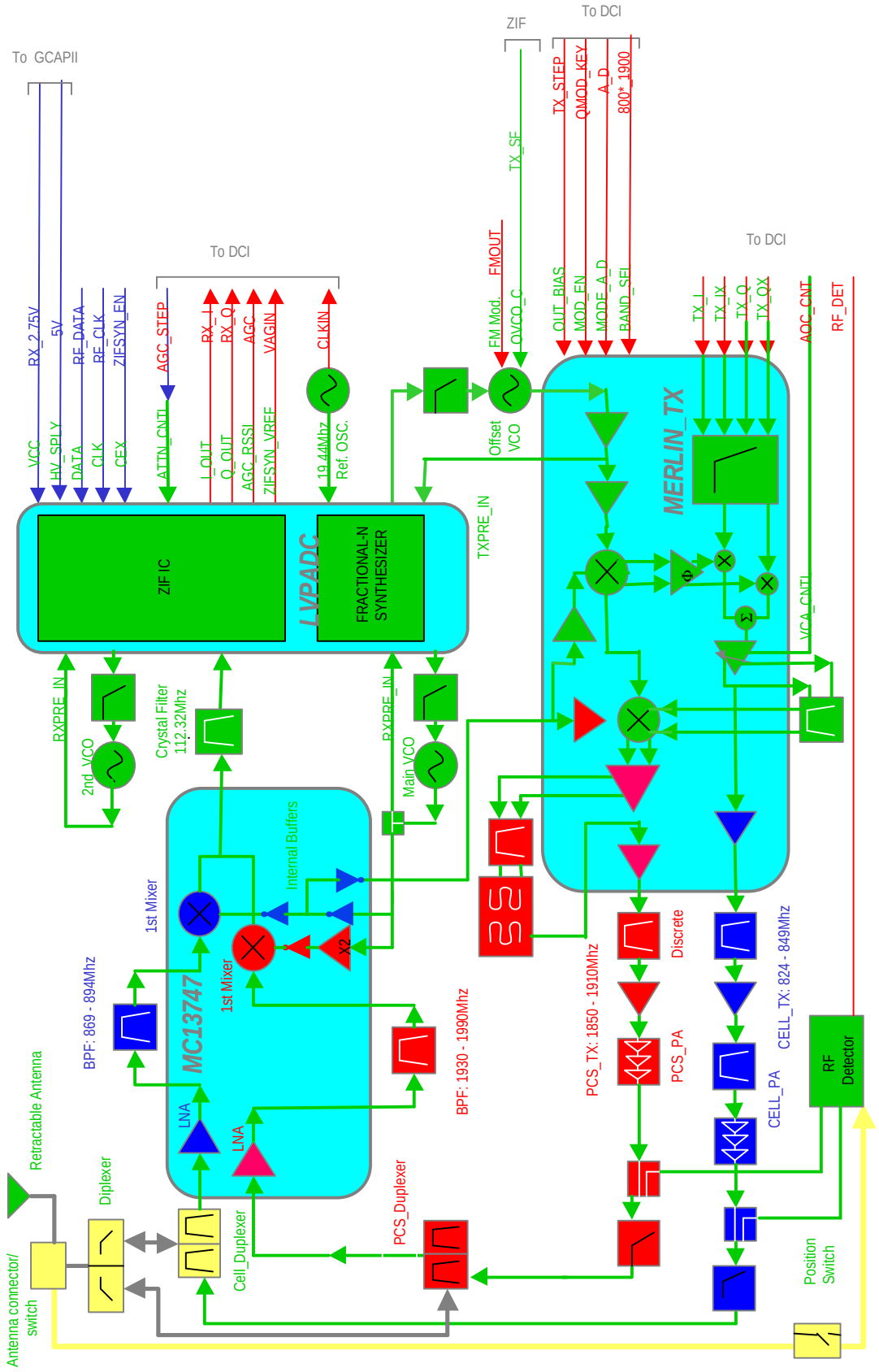

Figure 40. RF Block Diagram

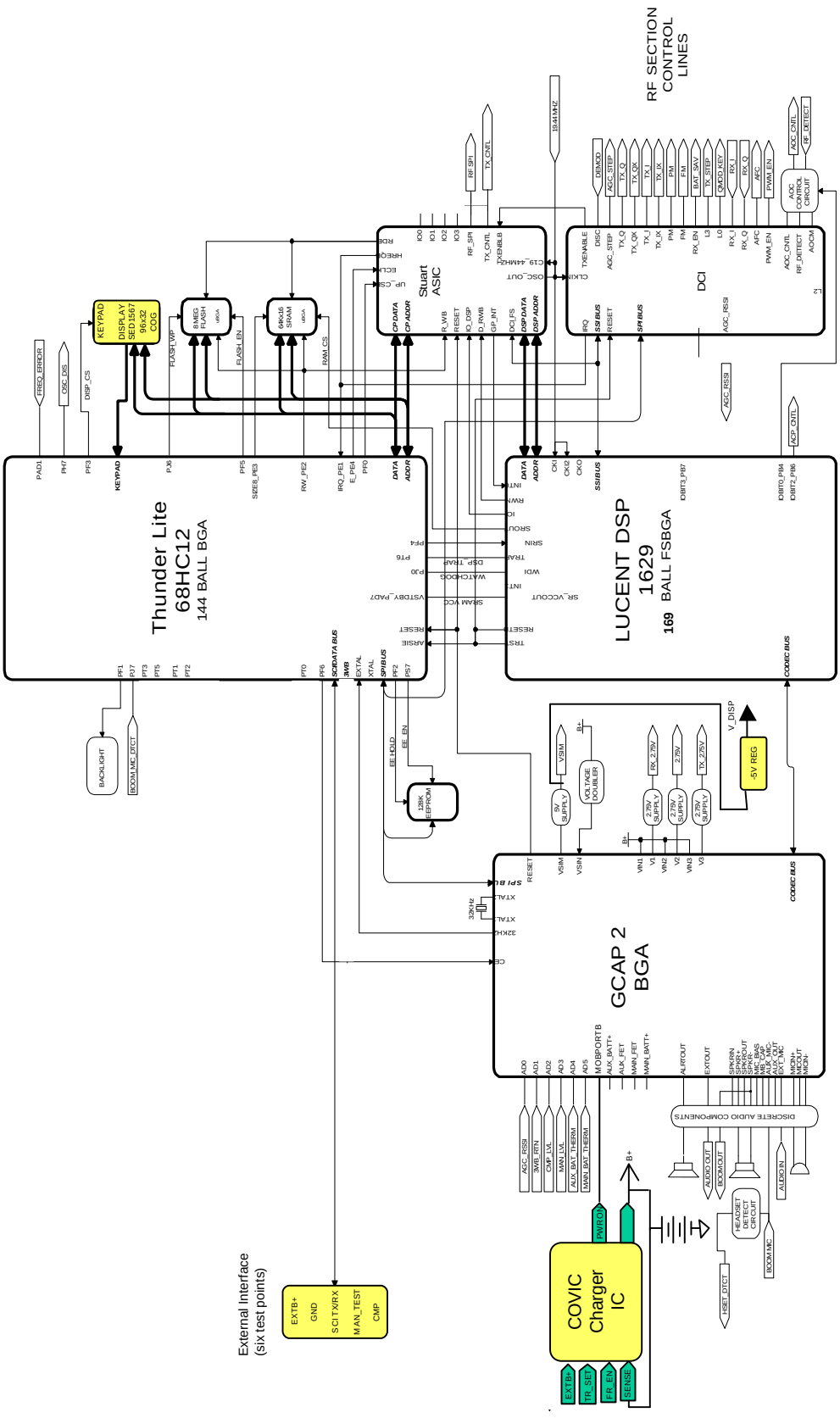

Figure 41. AL Block Diagram

Service Diagrams

Introduction

The service diagrams were carefully prepared to allow a Motorola certified technician to easily troubleshoot cellular phone failures. Our professional staff provided directional labels, color coded traces, measurement values and other guidelines to help a technician troubleshoot a cellular phone with speed and accuracy.

We worked hard in trying to provide the best service diagrams, therefore, to avoid cluttered diagrams, we excluded some components from the service diagrams. Our professional staff carefully selected to excluded components that are unlikely to fail.

Test Point Measurements

The measurements labeled on the service diagrams are approximate values and may vary slightly. These measurements are dependent on the accuracy of the test equipment.

It is strongly recommended that the test equipment calibration schedule be followed as stated by the manufacturer. RF probes should be calibrated for each frequency in which tests are going to be performed.

The types of probes used will also affect measurement values. Test probes and cables should be tested for RF losses and loose connections.

Because of the sensitivity of RF, measured readings will be greatly affected if they're taken in certain locations. To get the most accurate readings, take measurements nearest to the labeled measurement on the service diagram.

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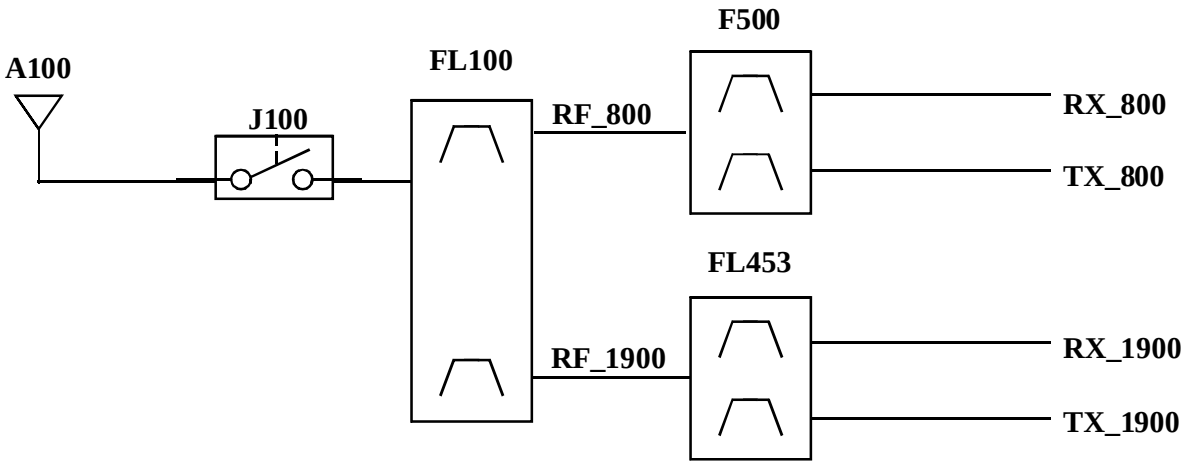
TDMA T2290/T2297: Antenna Circuit



B2

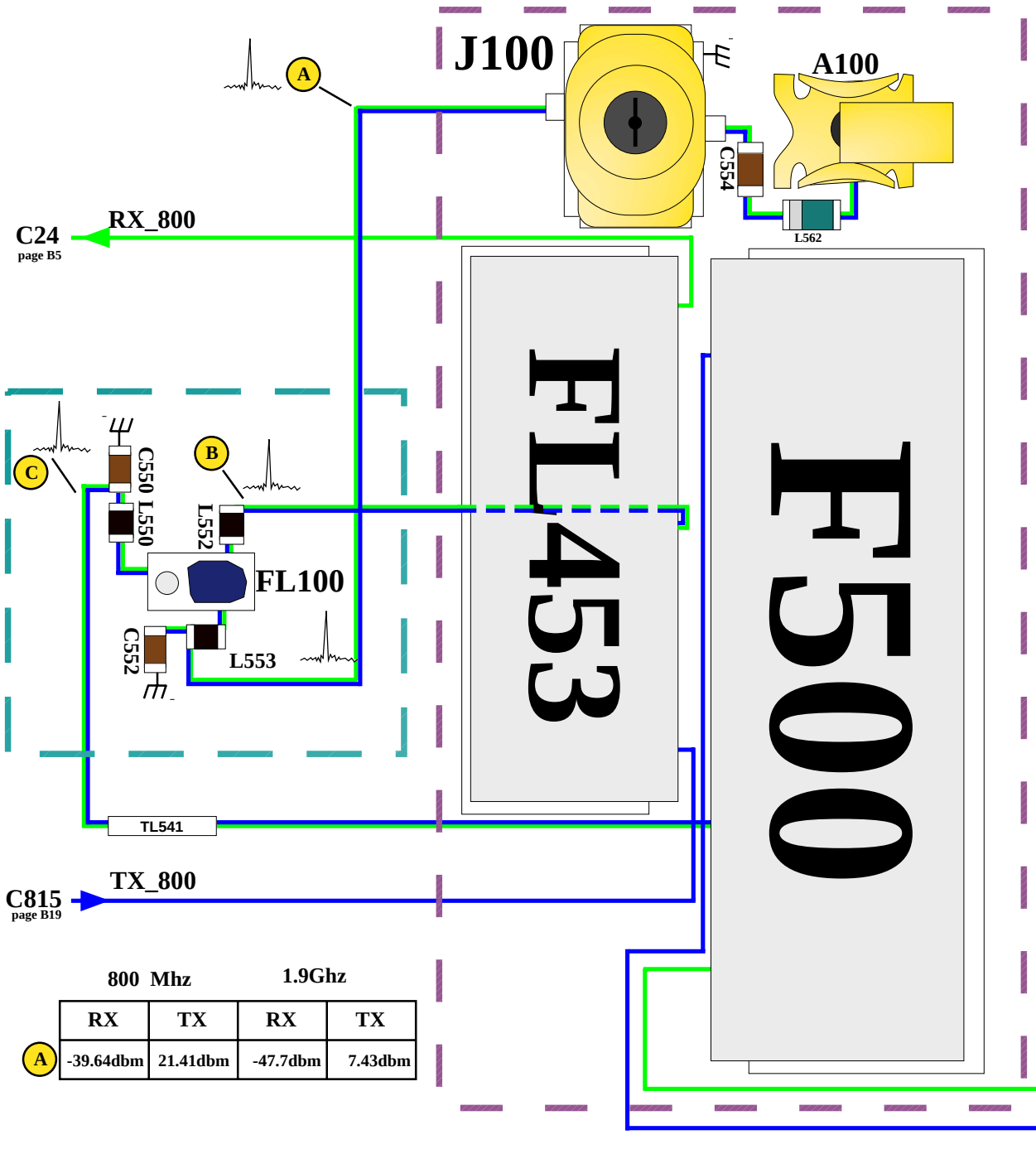
Description

A100 is the internal antenna port for dual band operation(800 &1900MHz). An antenna tap(J100) is used to allow a RF connection to test equipment for proper diagnostic testing. When nothing is inserted in J100, the switch is closed, allowing the internal antenna path to be used. If a connection is inserted in J100, the switch will open, not allowing the internal antenna path to be used. During this state the external RF path will be used.

Diplexer FL100 is used to isolate the two operating frequency bands. The cellular(800MHz) frequencies will be routed to duplexer F500. The PCS(1900MHz) frequencies will be routed to duplexer FL453.

F500 is a 800MHz duplexer used to isolate the cellular(800MHz) transmit and receive frequencies. FL453 is a 1900MHz duplexer used to isolate the PCS(1900MHz) transmit and receive frequencies.

TDMA T2290/T2297: Antenna Circuit



	800 Mhz		1.9Ghz	
	RX	TX	RX	TX
A	-39.64dbm	21.41dbm	-47.7dbm	7.43dbm

	Channel: 333	
Cellular TX Freq:		834.99MHz
PCS TX Freq:		1859.97MHz
Cellular RX Input Freq:		879.99MHz
PCS RX Input Freq:		1940.01MHz
RX Input:		-20dBm
TX Power Level 2		

TX SIGNAL

RX SIGNAL

Colored boxes represent the area in which the components are placed.

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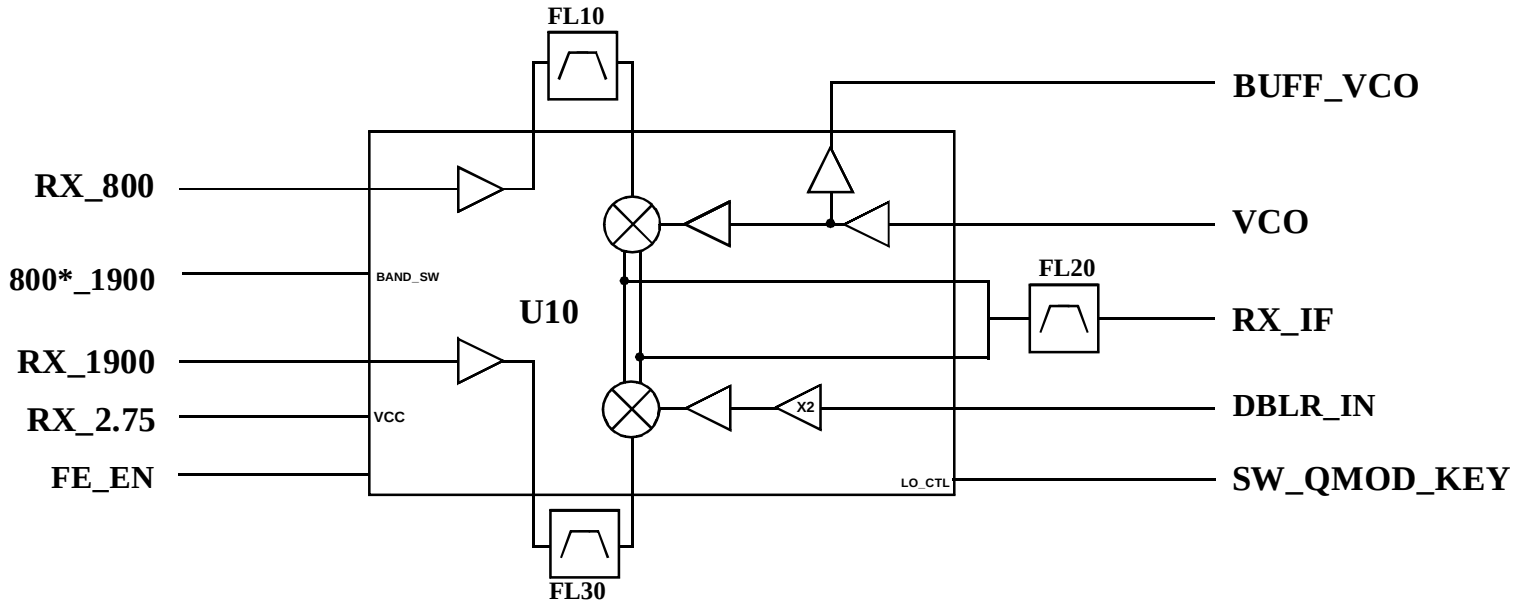
800MHz	RX	TX
C	-32.97dbm	15.12dbm

1.9GHz	RX	TX
B	-38.55dbm	5.60dbm

B3

TDMA T2290/T2297: Front End IC(U10)



B4

Description

The RX front end IC(U10) is used as a first amplifier and downconverter for dual-band RF applications. It removes the RX carrier frequency to produce the RX IF signal. U10 also has some internal LNAs for the receive signals and buffers for the VCO signals.

U10 has two RF input ports. One is used for the 800MHz receive signal and the other is used for the 1900MHz receive signal. Both signals are amplified within U10 and then routed to an external filter(FL10, FL30). The signal is then injected into the Down Converter of U10.

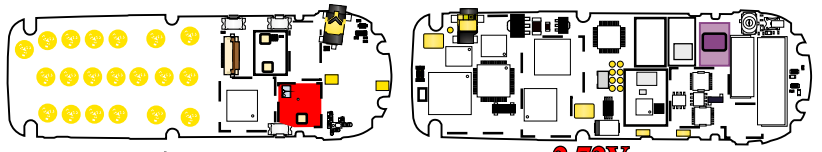
In 800MHz mode, the receive signal is mixed with the VCO and the result is the receive intermediate frquency(IF) signal which is filtered by FL20 prior to entering the ZIF/ZYN IC(U110).

In 1900MHz mode, the VCO output (**DBLR_IN**) goes through a frequency doubler internal to U10 before getting mixed with the 1900MHz receive signal. This process allows the 1900MHz carrier frequency to be removed without the need of a second VCO.

Line 800*_1900 is used to select which frequency path will be enabled for U10. Line 800*_1900 is high in 800MHz mode and low in 1900MHz mode.

Line **FE_EN** enables or disables normal operation of U10. A low state at **FE_EN** will disable U10. This line is used to disable U10 when the transceiver is in it's idle or transmit slot state. It is also used during sleep mode conditions.

TDMA T2290/T2297: Front End IC



Channel: 333
Cellular RX Input Freq: 879.99MHz
PCS RX Input Freq: 1940.01MHz
RX Input: -20dBm
VCO SIGNAL
RX SIGNAL
VOLTAGE SUPPLIES
Colored boxes represent the area in which the components are placed.

B5

-18.3dbm 1940.01 Mhz
-20.1dbm 1940.01 Mhz
2.72V
RX_2.75V page B25
FL30
C32
C38
L31
C35
C34
C30
R30
L30
C33
-35.18dbm 1940.01 Mhz
C36
RX_1900
FL453 page B3
C1
A SW_QMOD_KEY
Q1501 page B25
C2
B 800*_1900
U1907-64 page B35
C37
C FE_EN
U1800-18 page B23
L11
R60
U10
IF-
IF+
2.72V
RX_2.75V page B25
R3
C3
C4
-34.79dBm 1006.2Mhz
BUFF_VCO
R53 page B13
R52
C52
C5
L40
2.72V
RX_2.75V page B25
DBLR_IN
R808 page B9
VCO
R808 page B9
-16.13dBm 1006.252Mhz
C16
L968
C54
C53
C51
C13
-8.12dBm 112.32Mhz
-14.7dBm 893.97Mhz
FL10
C10
-30.16dBm 893.97Mhz
L12
C24
RX_800
F500 page B3
2.72V
RX_2.75V page B25
C11
C15
C12
C14
-14.9dBm 893.97Mhz
RX_IF
C1806 page B7
FL20
C20
C21
C25
C26
C23
L20
L21
L23
2.72V
RX_2.75V page B25

TX	On	Off	Band	800	1900	RX	On	Off
A	2.87V	0V	B	0V	2.81V	C	⎍	0V

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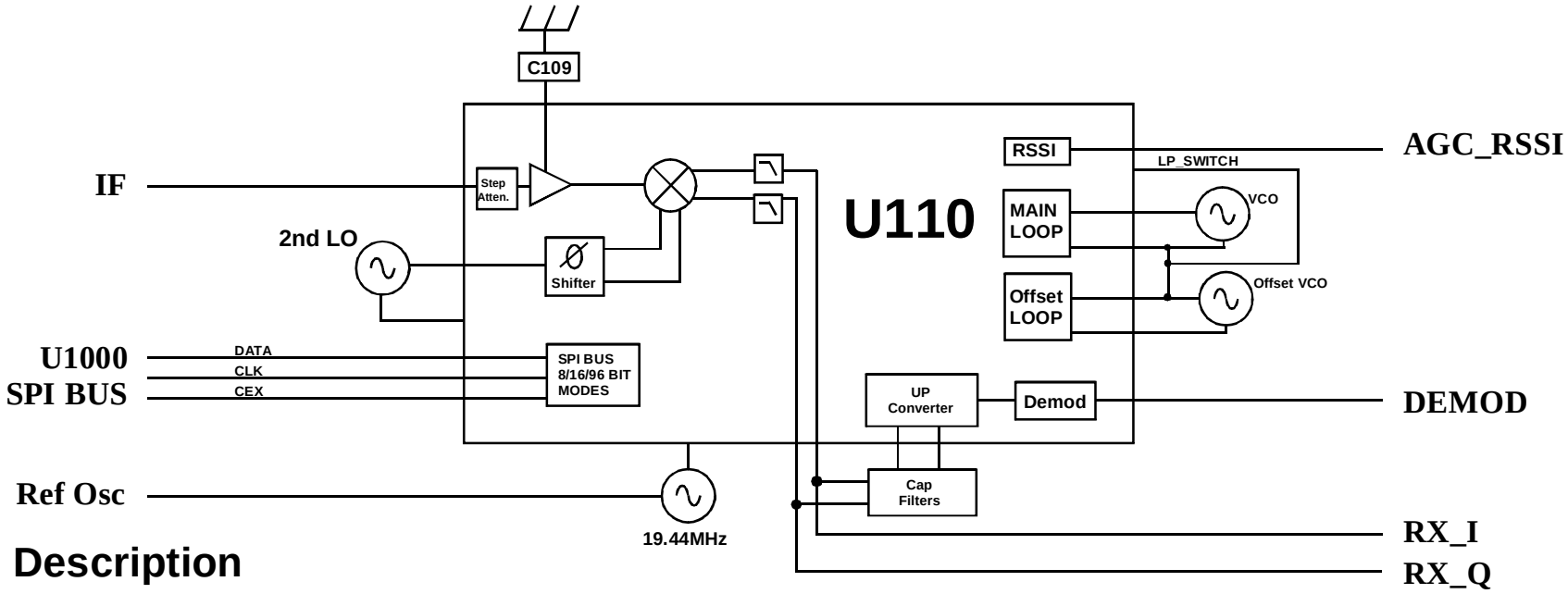
TDMA T2290/T2297: ZIF_SYNTH (U110)



B6

Description

U110(ZIF_SYNTH) can be divided into two functional subsystems: The ZIF (Zero-Intermediate-Frequency) which provides all of the functions of the back-end of a receiver, and the SYN (SYNthesizer) which contains phase-locked loops and modulators to produce the Local Oscillator (LO) and modulated transmit carrier.

The ZIF implements the back end of the receiver. The incoming signal is attenuated, amplified and mixed down to an extremely low frequency(Baseband)-not quite DC. The first amplifier and an Automatic Gain Control(AGC) circuit adjusts the amplifier gain to maintain a constant level in the baseband filter. C109 is used to add stability to the AGC circuit.

The first mixing that occurs in the ZIF requires a 2nd Local Oscillator that is running at 221.184MHz. The 2nd LO is divided down then phased shifted before being mixed with the IF signal., producing the baseband signal

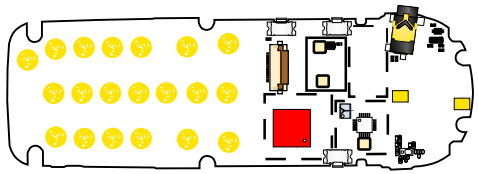
The baseband signal is low-pass filtered using a programmable low-pass filter. In TDMA mode, the baseband signal is routed to U1800(DCI) via the RX_I and RX_Q lines. In analog mode, the baseband signal is up-converted and then FM-demodulated, producing the DEMOD signal which is routed to U1800(DCI) for filtering and de-emphasis.

The RSSI(Receive Signal Strength Indicator) is a voltage that increases with respect to the received signal strength.

The SPI Bus is a serial interface used to program the internal filters and frequency dividers for U110, allowing selectivity of cellular channels.

RF 19.44Mhz input is used to provide a frequency reference for U110.

TDMA T2290/T2297: ZIF_SYNTH (U110)



RX Input	<-52dBm	>-52dBm
A	1.81V	2.83V

TX_SF 2.6v
2.48v
5v
5V page B25
4.8v HVCC
RX_2.75V page B25 2.75v
4.8v HVCC
-15.99dbm@157.32Mhz -18.82dbm@192.4Mhz
OVCO_FDBK
L351 page B13
TXCP_ADA
R308 page B11
TXCP_OUT
C303 page B11
RX_2.75V page B25 2.75v
650mvp-p RF_19.44MHZ
U150 page B21
RXCP_OUT
C884 page B9
RXCP_ADA
R893 page B9
ZIF_SYN_EN
U1907 page B35
RF_CLOCK
U1907 page B35
RF_DATA
U1907 page B35
FREQ_ERROR
U1000 page B37
DEMOD
U1800 page B23
LP_SWITCH
C302,C888 page B11 page B9
AGC_RSSI
U1500 page B25
RX_Q
U1800-25 page B23
450mvp-p
RX_I
U1800-24 page B23
ZIFSYN_VREF 1.4v
U1800-22 page B23

C1505 C262 C252 C251 C203 -16.3dbm@992.31Mhz RXPRE_IN
C18889
R807 page B9
2.52v RX_SF
C204 C273 C274 C263 C253 C261 C202 R201 C129 1.61v
C272 C128
C134 C127 C124 4.8v HVCC
2.75v RX_2.75V page B25
C133 R122 C125 CR100
C126 C1817
R131 R121
C121 C122 L962 -47.5dbm 221.184Mhz
C135 C1816
C109 C1814
2.75v RX_2.75V page B25
C131 C113 C111 C1813
C1811 C1803 C1807 C1809 C1810 C1812 C1815 C1806 C100 C108 L101
-24.68dbm@112.32Mhz RX_IF
FL20 page B25
A AGC_STEP
U1800-45 page B23
0v BATT_SAV
U1800-16 page B23

U110
TXPRE_VR
SF_BYP
HV_BYP
VI_BYP
RXPRE_VR
COLL
BASE
EMIT
AGC_BYP
DEMOD
CRAMP
VAG_REF
VREF

Channel: 333
Cellular RX Input Freq: 879.99MHz
PCS RX Input Freq: 1940.01MHz
RX Input: -20dBm
VCO SIGNAL
TX SIGNAL
RX SIGNAL
VOLTAGE SUPPLIES
Colored boxes represent the area in which the components are placed.

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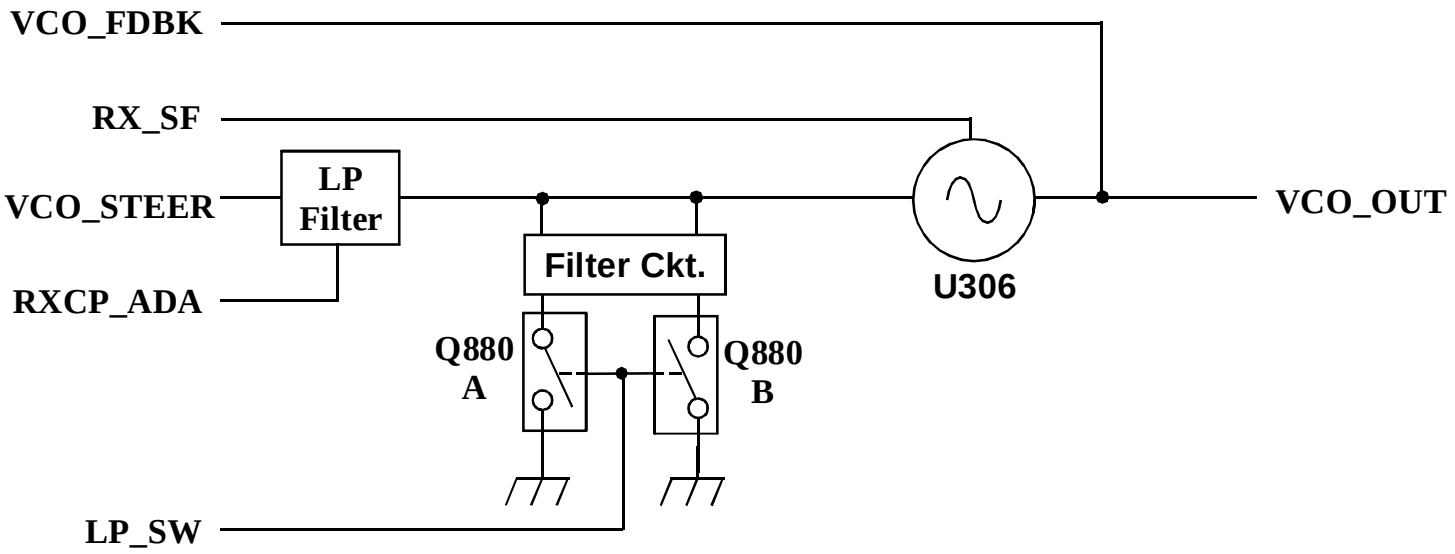
B7

TDMA T2290/T2297: VCO



B8

Description

U306 is the local oscillator module used to add frequency selectivity to the transceiver. The frequency of oscillation is dependent on the channel and frequency band that the transceiver will be operating in. The frequency is controlled by U110. U110 will receive channel information via the SPI bus and adjust the frequency of U306 by adjusting the voltage level to the input (**VCO_STEER**) of U306.

The output of U306 is split into two paths. One path (**VCO_FDBK**) is used to feed back the generated signal to U110. The signal is prescaled and sent through a phase detector for proper frequency locking. The second path (**VCO_OUT**) is sent to the front end IC(U10). This signal is used for proper downconversion of the receive signal.

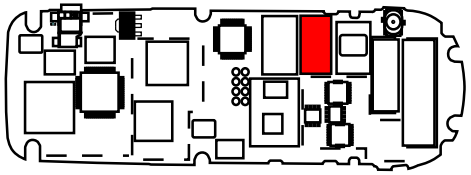
When the transceiver is operating in the 800MHz band, U306 will oscillate at a frequency of 112.32+RX frequency. In the 1900MHz band, U306 will oscillate at a frequency of (112.32+RX)/2.

RX_SF (Super Filter) comes from U110 and provides a clean supply voltage to the VCO module.

LP_SWITCH control comes from U110. In Analog mode, the input to Q880 becomes high causing it to switch on. This condition will complete the filter circuit path to ground, thus allowing the filter ciruitry to become active on the VCO_STEER line. This filter circuit is used to improve phase noise due to stringent adjacent channels in Analog mode.

The **RXCP_ADA** is a loop filter adapt output. During a high current state R893 will be grounded. This will increase the loop filter bandwidth by decreasing the amount of resistance at the discharge path of C884. During low curent conditions R893 will not be grounded. This will decrease the loop filter bandwidth by increasing the amount of resistance at the discharge path of C884.

TDMA T2290/T2297: VCO (U306)



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Channel: 333
Cellular VCO Freq: 992.31MHz
PCS VCO Freq: 1026.165MHz

VCO Signal

VOLTAGE SUPPLIES

Colored boxes represent the area in which the components are placed.

B9

A

RXCP_OUT

U110 page B7

Channel	991	333	799
A	1.25V	1.69V	2.04V

C883 R881 R882 C886 Q880 .034v .034v R893 C884 2.74v R884 C888

B

U110 page B7 LP_SW

.04V RX_CP_ADA

U110 page B7

C885 R883 C882 C887 C899 C898

RX_SF page B7 2.51V

1.5v

	Analog	Digital
B	1.69V	2.59V

U306

-14.88 dBm@1900MHHz
1026.165MHz

-16.3 dBm@800MHz
992.31MHz

C202 page B7 VCO_FDBK

R807 R808 C628

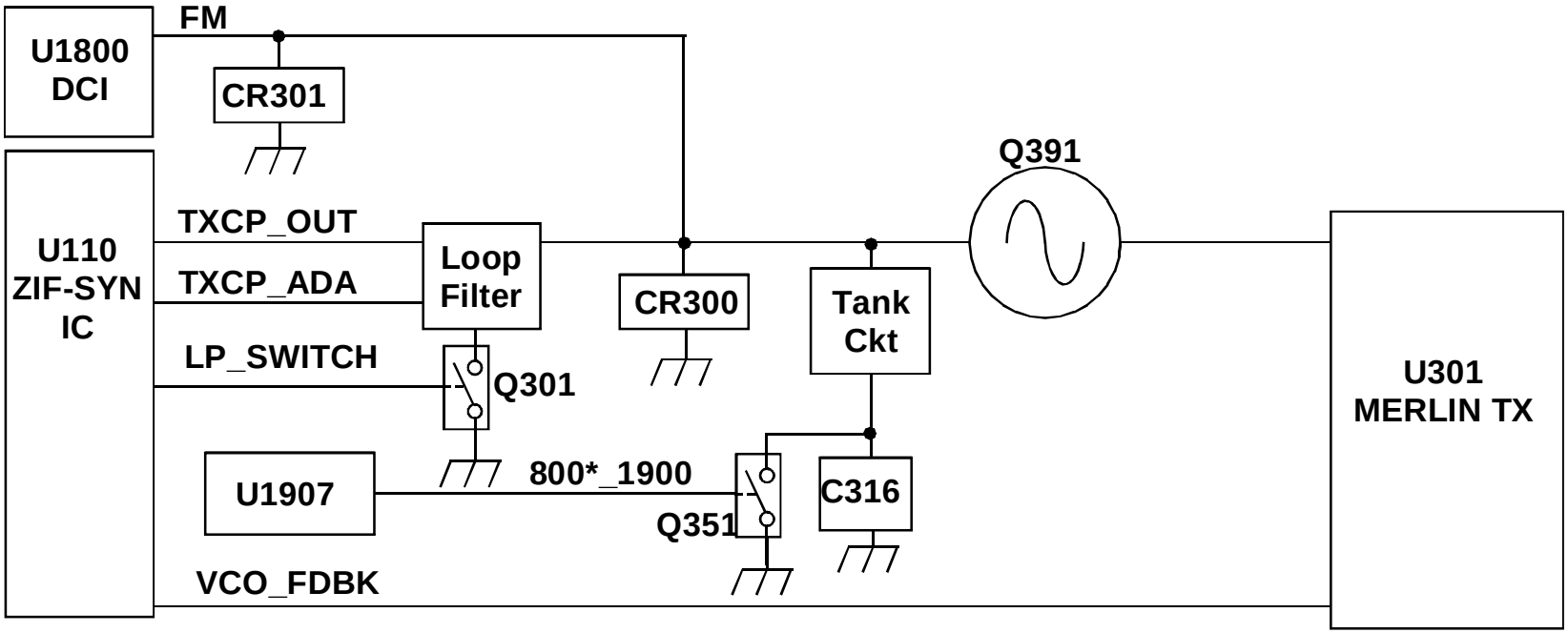
-8.31 dBm@1900MHHz
1026.165MHz

-12.61 dBm@800MHz
992.31MHz

VCO_OUT

C16 page B5

TDMA T2290/T2297: TX Offset Oscillator



B10

Description

The offset oscillator frequency is controlled by U110(ZIF/SYN) via **TXCP_OUT**. The operating frequency will depend on the dc biasing of CR300. The offset oscillator frequency is 157.32MHz in 800MHz mode, an d 192.36MHz in 1900MHz mode.

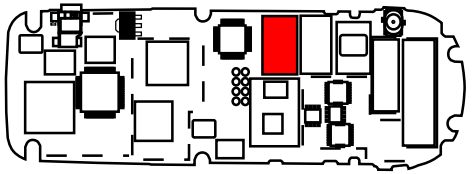
The two operating frequencies are controlled by the 800*_1900 line. A high state at 800*_1900 will switch Q351 on. This condition will bypass path to ground for C316, thus C316 is not be active with the tank circuit. During this state, the TX offset oscillator will operate at 192.36MHz. A low state at 800*_1900 will switch Q351 off. This condition will allow C316 to remain active with the tank circuit. During this state the TX offset oscillator will operate at 157.32MHz.

The **TXCP_ADA** is a loop filter adapt output. During a high current state R308 will be grounded. This will increase the loop filter bandwidth by decreasing the amount of resistance at the discharge path of C303. During low curent conditions R308 will not be grounded. This will decrease the loop filter bandwidth by increasing the amount of resistance at the discharge path of C303.

LP_SWITCH control comes from U110. In Analog mode, the input to Q301 becomes high causing it to switch on. This condition will complete the filter circuit path to ground, thus allowing the filter ciruitry to become active on the VCO_STEER line. This filter circuit is used to improve phase noise due to stringent adjacent channels in Analo g mode.

In analog mode the FM signal comes from U1800(DCI) pin 39 and is modulated directly in the offset oscillator. The offset oscillator with the FM then enters U301 (QMOD). The Quadmod (U301) will fe ed back the offset frequency to U110 for proper PLL(Phase Locked Loop) operation.

TDMA T2290/T2297: TX Offset Oscillator



TX_SF page B7 — 2.57V

-11.39dBm@1900MHz
192.36MHz

-11.29 dBm@800MHz
157.32MHz

C350 page B13 — OVCO

R393, C312, R350, C311

C316, C399, C317, R305

A — 800*_1900 — U1907-64 page B35

B — L302, Q351

Channel: 333
Cellular TX Offset Freq: 157.32MHz
PCS TX Offset Freq: 192.36MHz
TX SIGNAL
VOLTAGE SUPPLIES
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0.9Vpp@10kHz — FM — U1800-39 page B23

Q391, L303, CR302, C306, C308

TX_SF page B7 — 2.57V

C313, R391, C310, C309, R306, R304, C307

2.57V — TX_SF page B7

R392, CR300, R303, CR301

U110 page B7 — TXCP_ADA — 0V

R308, R301, C315, C304, C305, R302

C — TXCP_OUT — U110 page B7

Mode

	Analog	Digital
D	2.72V	0V

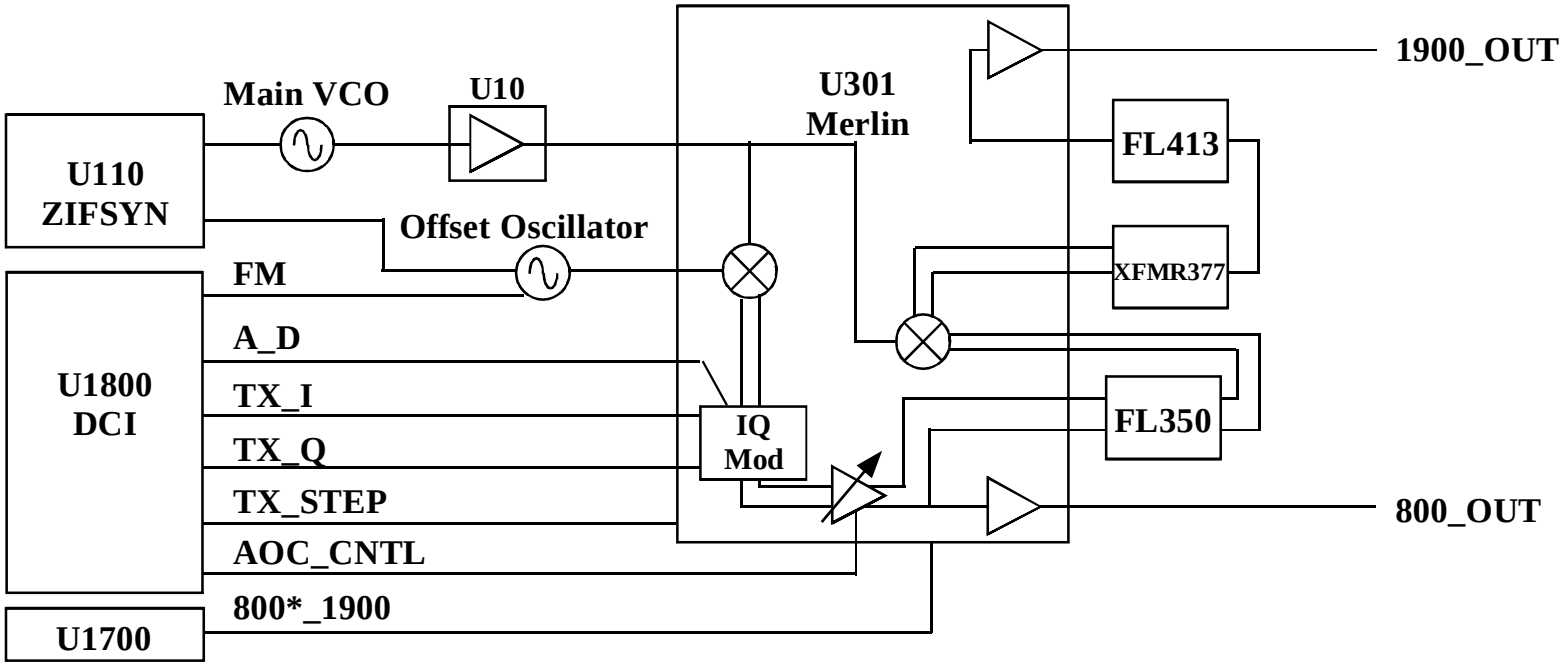
Q301, C302, C303

U110 page B7 — LP_SW — D

Band	800	1900
A	2.9V	.05V
B	2.97V	.08V
C	1.4V	1.85V

B11

TDMA T2290/T2297: MERLIN (U301)



B12

Description

U301 is a TX modulator. It takes the TX information and modulates it on a carrier for RF transmission.

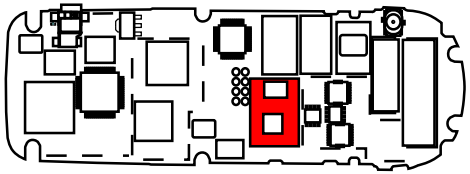
In analog mode the offset oscillator with the FM enters U301 and gets mixed with the main VCO. The resulting signal is a differential carrier with the modulated information. The carrier is then passed through an IQ modulator. The A_D line controls the state of the IQ modulator. In analog mode, the IQ modulator simply feeds the carrier though to a voltage controlled amplifier(VCA). The gain of the VCA is controlled via the AOC_CNTL line, therefore, controlling the TX power steps of the transceiver. Once the carrier passes through the VCA, it passes through the cellular final power amplifier which is still internal to U301.

In digital mode the offset oscillator doesn't contain the modulated information from the FM line. The offset oscillator is mixed with the main VCO and a differential output signal is sent through the IQ modulator. In digital mode, the A_D line configures the IQ modulator to allow IQ modulation to the carrier. The result carrier signal is then passed through the Voltage Controlled Amplifier(VCA). The gain of the VCA is adjusted by the AOC_CNTL line, thus controlling the TX digital power steps of the transceiver.

When operating in the 800MHz band the carrier is routed through the cellular final power amplifier and out to the 800MHz transmit circuit. In 1900MHz mode the cellular final power amplifier is disabled via the 800*_1900 line and the VCA output is routed to filter FL350 for noise and spurious performance improvement. The differential output is then routed into a PCS upconverter where the signal is upconvertered to a PCS frequency by mixing the carrier signal with the main VCO. The output of the PCS upconverter is then routed to a Balun(XFMR377) for single ended signal conversion. The newly created single ended TX carrier signal is then filtered by FL413 and routed through the PCS power amplifier internal to U301 before entering the 1900 TX exciter circuit.

The TX_STEP line is used to control the biasing to the cellular final amplifier, PCS final amplifier, and the PCS upconverter. This line is used as a course gain control for the final amplifiers and PCS upconverter.

TDMA T2290/T2297: Merlin TX(U301)



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Channel: 333
Cellular TX Freq: 834.99MHz
PCS TX Freq: 1859.97MHz

VCO SIGNAL
TX SIGNAL
VOLTAGE SUPPLIES

Colored boxes represent the area in which the components are placed.

-15.95 dBm@1900MHz
192.36 MHz

-20.39 dBm@800MHz
157.32 MHz

OVCO

R350
page B11

2.57V

TX_SF
page B7

L351

-18.82 dBm@1900MHz
192.36 MHz

-15.99 dBm@800MHz
157.32 MHz

OVCO_FDBK

C272
page B7

C351

C350

FL413

-29.35dbm@1.859Ghz

C1508

-29.31 dBm
1859.97MHz

VCO_BUFF

C52
page B5

-9.11 dBm@1900MHz
1026.165 MHz

-23.85 dBm@800MHz
992.31 MHz

R311

R53

C205

C334

C487

C339

C454

C413

C402

C412

XFMR377

C447

C395

C428

C401

C389

L378

L381

C333

L401

C499

2.83V

TX_2.75
page B25

-27.57 dBm
1859.97MHz

1900_OUT

R408
page B15

-5.65 dBm
834.99MHz

800_OUT

FL452
page B15

VCC_OFFSET
OVCO_E

UPCON_OUT
UPCON_OUTX
NC_1061

UPCON_IN
UPCON_INX

U301
MERLIN

VCO_OUT
VCC_OFFSET2
VCA_OUTX
VCA_OUT

FL350

C300

L452

R452

L451

C425

C335

R425

R403

C427

C343

R342

R341

C18873

C18871

C342

D

800*_1900

U1907-64
page B35

TX_STEP

U1800-17
page B23

TX_QX

U1800-41
page B23

TX_Q

U1800-42
page B23

TX_IX

U1800-37
page B23

TX_I

U1800-38
page B23

2.83V

TX_2.75
page B25

TX_2.75
page B25

2.83V

C

QMOD_KEY

U1800-20
page B23

B

A_D

U1800-14
page B23

A

AOC_CNTL

U1800-30
page B23

Power Step	2	3	4	5	6	7
A	2.11v	1.81v	1.81v	1.38v	1.66v	1.52v

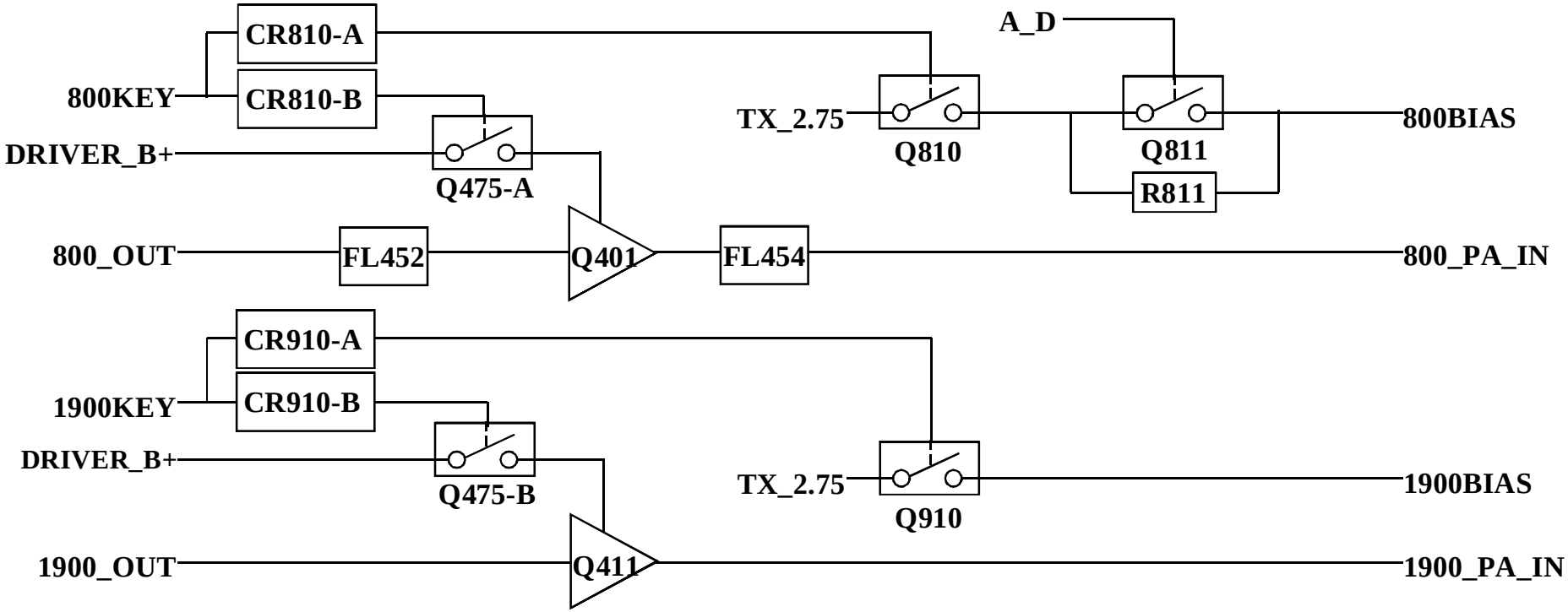
TX	On	Off
C	.09V	2.83V

Band	800	1900
D	.05V	

	Analog	Digital
B	2.98V	.06V

B13

TDMA T2290/T2297: Exciter



B14

Description

After the desired transmit information is modulated with a TX carrier frequency, enough signal power needs to be provided for RF transmission through the antenna. The exciter stage is used to relieve amplification of the final stage PA. This reduces excess heat dissipation and overloading of the final stage PA.

In 800MHz mode, the TX signal passses through FL452 and then is amplified by Q401. Q401 is driven on by suppling DRIVER_B+ through Q475-A. Q475-A can be switched on or off via the 800KEY line. In 800MHz TX mode, 800KEY is low. This state brings the gate of Q475-A to a low level, causing Q475-A to switch on.

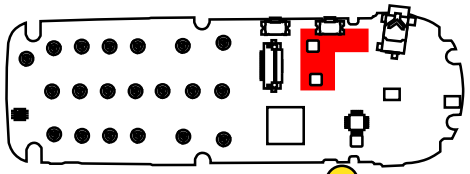
There are two operating modes in the 800MHz band, analog and digital. In 800MHz mode Q810 is switched on with a low level of the gate. The output of Q810 will then be used to provide the biasing voltage for the final stage PA(U801).

The 800BIAS voltage level determines the operating condition of the final stage PA. A lower voltage level at 800BIAS denotes digital mode and a higher voltage level denotes analog mode. In analog mode, A_D is pulled high causing Q811 to be switched off. This state causes a voltage drop across R811, thus, having a lower voltage level at 800BIAS. In digital mode A_D is pulled low causing Q811 to be switched on. During this state R811 is bypassed and 800BIAS will have a higher voltage level.

In 1900MHz mode, the TX signal is amplified by Q411. Q411 is driven on by suppling DRIVER_B+ through Q475-B. Q475-B can be switched on or off via the 1900KEY line. In 1900MHz mode, 1900KEY is low. This state brings the gate of Q475-B to a low level, causing Q475-B to switch on.

1900BIAS provides the proper biasing voltage for the final stage PA(U901). 1900BIAS is supplied from TX_2.75. In 1900MHz mode, having 1900KEY low will switch Q910 on.

TDMA T2290/T2297: Exciter



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B15

U1800-14 page B23 → A_D (A)

R802 page B17 ← 800BIAS (C)

DRIVER_B+ page B25 — 3.44V

R801 page B17 ← 800_PA_IN — -7.69 dBm 834.99MHz

C333 page B13 ← 1900_OUT — -25.96 dBm 1859.97MHz

FL454

R407, R408, R409, C411, C410, L403, R405, C406, L406, R10018, C998, C405, L405, L407, C414, C407

Q475 (G) — R10017, R10016 (H) — (K) (L)

Q401 — L404 — C404, C455 — -15.1dbm 834.99Mhz

Q411

FL452

L400, C452, R406, R450, R451, C400

-1.21 dBm 834.99MHz

-20.18 dBm 1859.97MHz — 1900_PA_IN → R999 page B17

C499 page B13 ← 800_OUT — -11.31dbm 843.99Mhz

-12.16 dBm 834.99MHz

Q811 (F) — R811

Q1804, Q1805

Q810 — R499 — 2.98V — TX_2.75 page B25

Q910 — R498

CR810, CR910

(I) 1900KEY* → U1907-61 page B35

(E) 1900KEY → Q901-4 page B17

(J) 800KEY* → U1907-62 page B35

(B) 800KEY → Q1807-4 page B17

(D) 1900BIAS → R906 page B17

(E) 1900KEY → Q1805

(B) 800KEY → Q1805

	Analog	Digital
A	2.95V	.11V
C	1.67V	1V

Channel: 333
Cellular TX Freq: 834.99MHz
PCS TX Freq: 1859.97MHz

TX SIGNAL

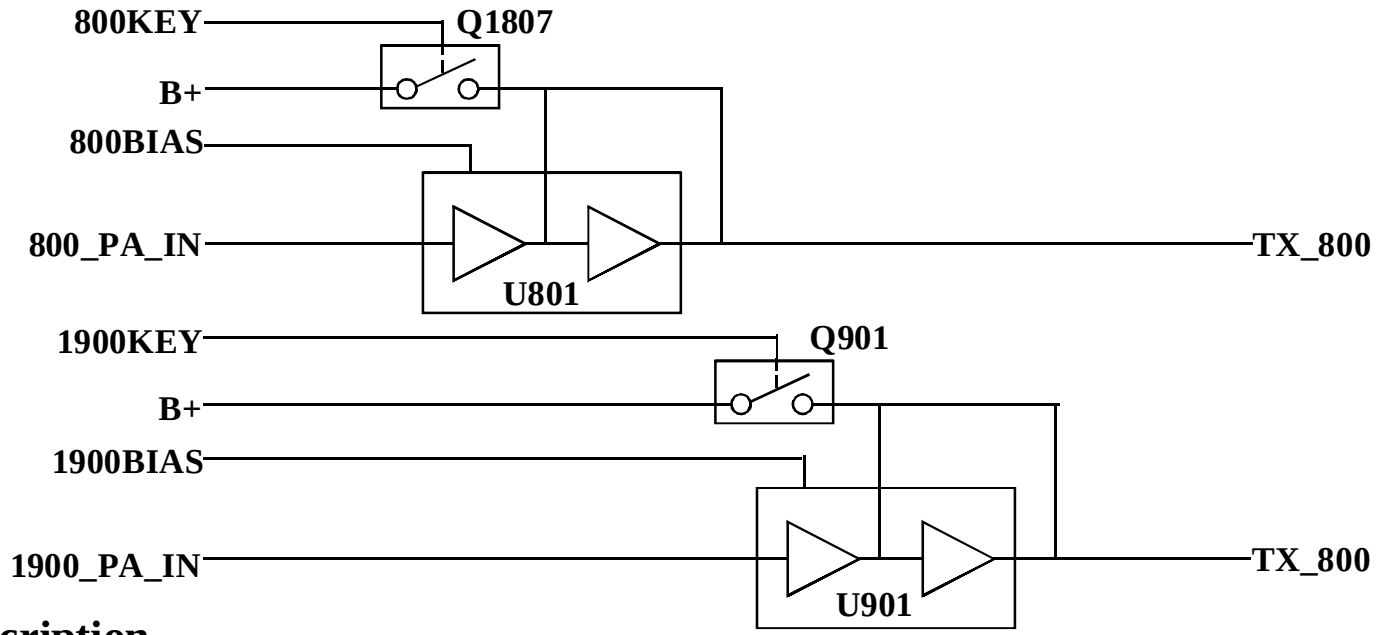
VOLTAGE SUPPLIES

Colored boxes represent the area in which the components are placed.

800TX	On	Off
B		4.47V
F		.04V
G		.27V
J		.04V
L		0V

1900TX	On	Off
D		.05V
E		4.46V
H		.05V
I		.05V
K		.04V

TDMA T2290/T2297: PA Circuit



Description

The final stage PA circuit provides the necessary amount of power for RF trasmission through an antenna. U801 is a PA module that is capable of operating in the 800MHz band under analog or digital mode.

In analog mode linearity of the PA is not as critical as when operating in digital mode. For this reason, effeiciency is a more important factor than linearity when operating in analog mode. In digital mode, because of its IQ modulation scheme, PA linearity is a more important factor than efficiency.

Efficiency and linearity is controlled by varying the biasing of the PA(U801). In 1900MHz mode only one biasing method is needed since 1900MHz mode only operates in digital mode.

Q1807 controls the supply voltage to U801. The PA supply is sourced from the B+ line. In 800MHz mode, 800KEY is held low causing Q1807 to switch on. When 800KEY is pulled high, Q1807 is turned off and the supply to U801 is cut off.

Q901 controls the supply voltage to U901. The PA supply is sourced from the B+ line. In 800MHz mode, 1900KEY is held low causing Q901 to switch on. When 1900KEY is pulled high, Q901 is turned off and the supply to U901 is cut off.

After the TX carrier is amplified it's sent to the duplex filter for final transmission through the antenna.

TDMA T2290/T2297: PA Circuit

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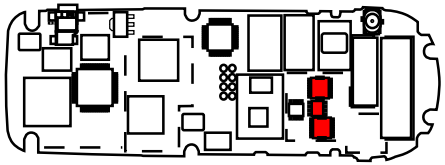
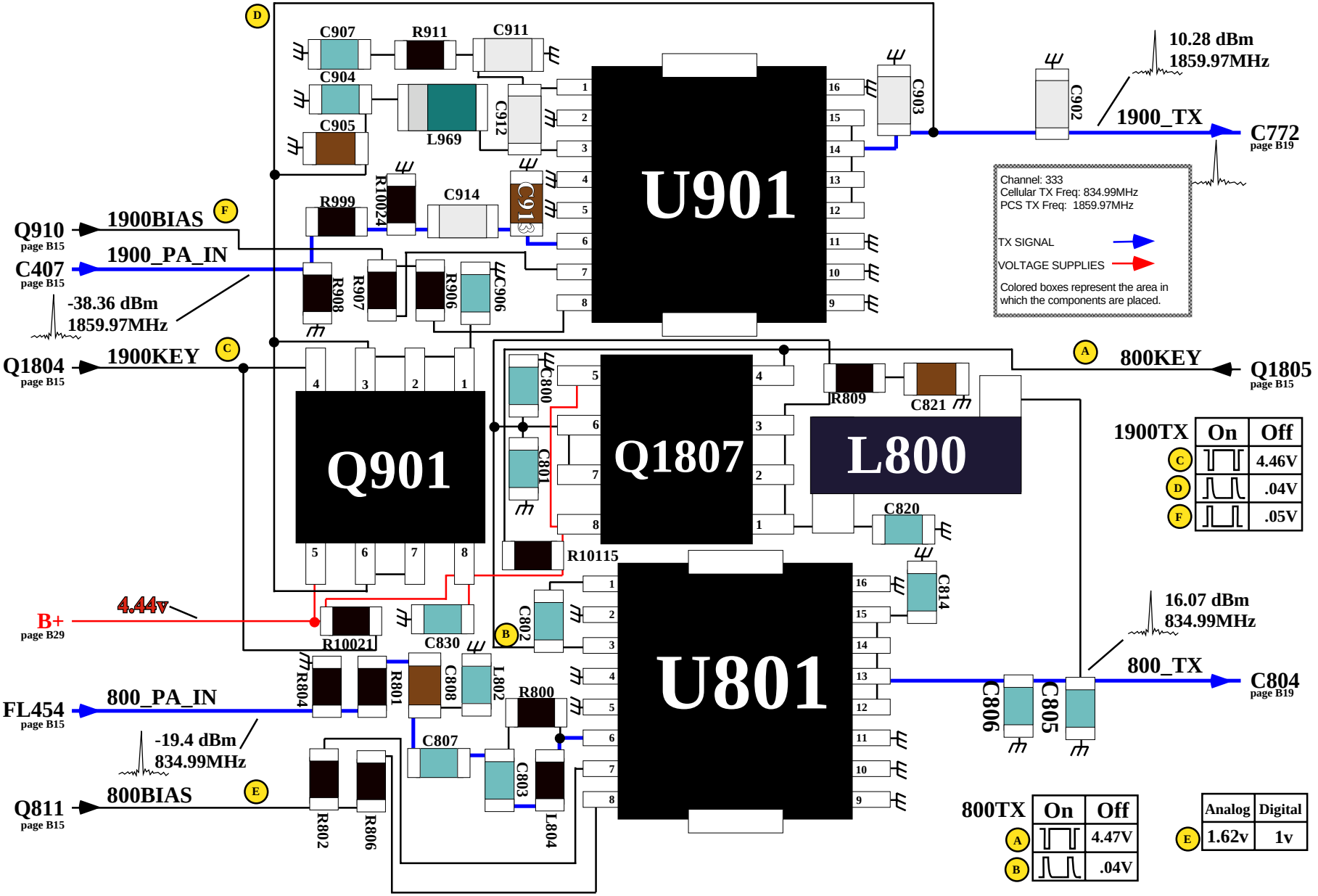
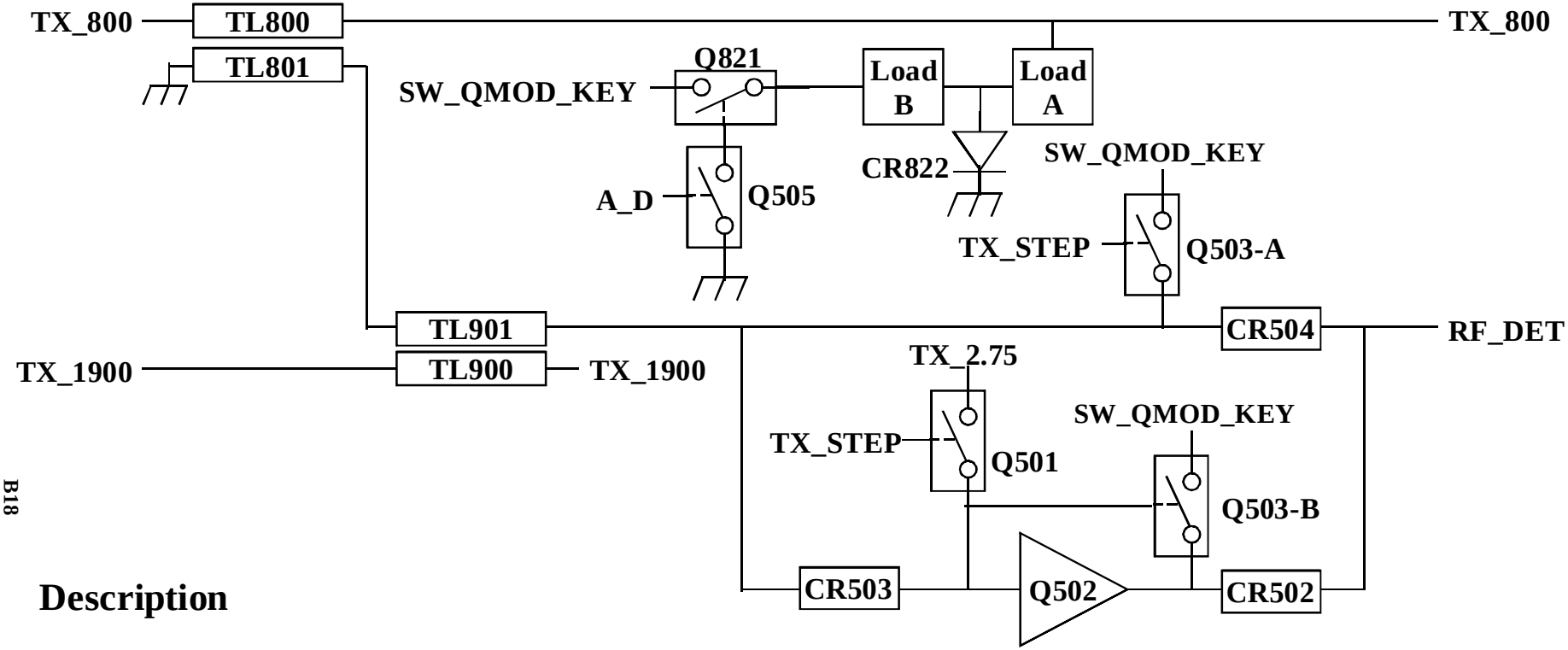




TDMA T2290/T2297: RF Detect/A_D Switch



B18

Description

The RF detect circuit is used to detect the RF amplitude level of the TX signal. RF detect reports back to U1800(DCI) pin 31, using a dc level, for amplitude stabilization. The RF detect circuit is RF coupled with the TX signal from either band, 800MHz or 1900MHz. The RF input is then converted into a dc level and sent to the RF_DETECT line. There are two stages in the RF detect circuit which are used to increase the dynamic range of the RF detect output. The two stages are controlled by the TX_STEP line input. TX_STEP is high when power steps 0 through 5 are used . TX_STEP is low when power steps 6 through 10 are used .

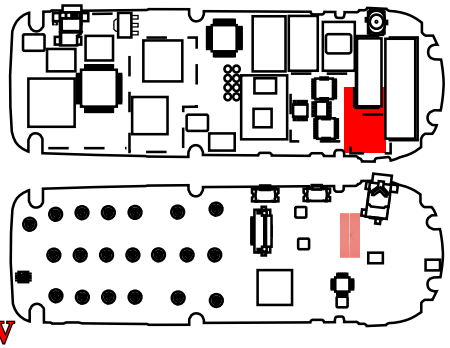
When TX_STEP is low Q503-A is switched on and Q503-B is switched off. Q501 inverts the state of Q503-B. This operation forward biases diode CR504. At the same time it cuts off the supply to diode CR502, thus not forward biasing CR502. When TX_STEP is high Q503-A is switched off and Q503-B is switched on. This operation cuts off the supply to diode CR504. At the same time current is supplied to amplifier Q502 and CR502. During low power steps the signal is sent directly to the RF _DET output through CR504. During high power steps the signal passes through amplifier Q502 and then sent to the RF _DET output through CR502.

Proper PA loads need to be defined when operating in 800MHz analog and 800MHz digital mode. This is done by making Load B active or inactive on the PA output path. When transmitting in 800MHz analog mode, LOAD A is used and LOAD B is bypassed. LOAD B is bypassed by allowing CR822 to be forward biased. Forward biasing CR822 will provide a ground state at the anode side, thus allowing only LOAD A(C823) to be present.

CR822 is forward biased by having a supply voltage present at the AD_SW line. When the A_D line is pulled down, Q505 is switched on, forcing the base of Q821 low. PNP transistor Q821 will then be switched on, allowing the output(AD_SW) to be pulled high from SW _QMOD_KEY.

In 800MHz digital mode, CR821 is not forward biased, thus having CR821 in an open state. During this state LOAD A and LOAD B are used for the PA load. To have CR822 in an open state, AD_SW is not pulled high by SW_QMOD_KEY. The AD_SW state is determined by the A_D line . Having a high state at A_D would switch Q505 off, thus not switching Q821 oon.

TDMA T2290/T2297: RF Detect/A_D Switch



2.97V
SW_QMOD_KEY
page B25
A
TX_STEP
U1800-17
page B23
2.88V
TX_2.75
page B25

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TX_2.75
page B25
2.87V

U901
page B17
1900_TX

TX_STEP	ON	OFF
C	0.2V	0.65V
D	0.6V	0.19V
E	0.18V	1.21V
F	0.19V	2.76V

8.43 dBm
1859.97MHz

TX_1900
FL453
page B3

Channel: 333
Cellular TX Freq: 834.99MHz
PCS TX Freq: 1859.97MHz

TX SIGNAL
VOLTAGE SUPPLIES
Colored boxes represent the area in which the components are placed.

B19

22.6 dBm
834.99MHz

U801
page B17
800_TX

B
RF_DET
R1806
page B23

	Analog	Digital
G	2.97V	.09V
H	.24V	.31V
I	1V	0V

TX_800
F500
page B3

23.5 dBm
834.99MHz

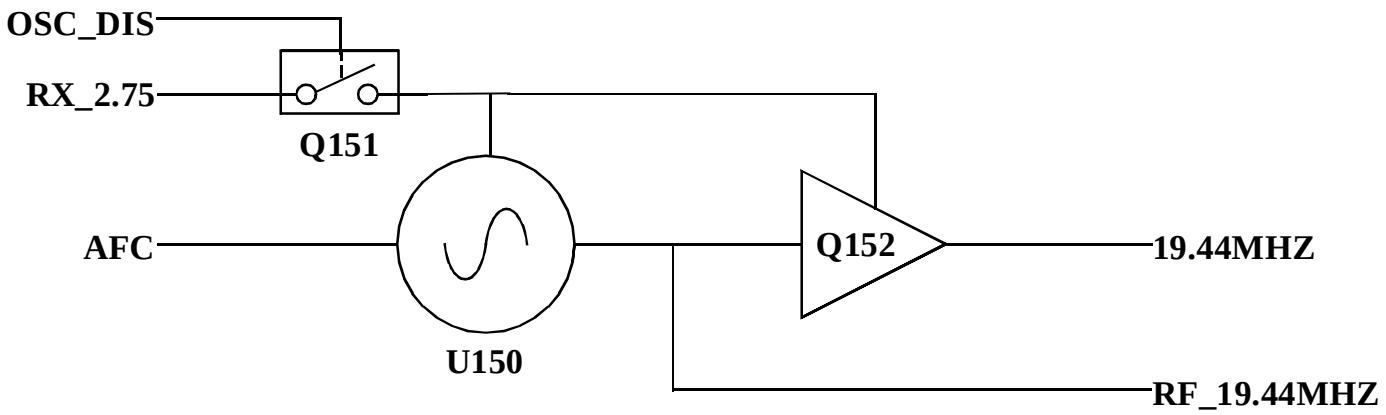
Power Step	2	3	4	5	6	7
A	2.89V	2.87V	2.87V	2.86V	.14V	.14V
B	1.51V	.991V	1.01V	.456V	1.24V	.94V

2.88V
LOAD_SW
U1800-13
page B23

2.97V
SW_QMOD_KEY
page B25

U1800-14
page B23
A_D
G

TDMA T2290/T2297: Reference Oscillator



B20

Description

The reference oscillator U150, operating at 19.44MHz, provides a "reference frequency" for the RF synthesizers and various logic circuits.

The OSC_DIS line which is controlled by U1000 (CPU) is used to turn off U150 during sleep mode. The OSC_DIS line switches Q151 on or off, controlling the supply voltage to U150 and Q152.

U1800 (DCI) can "fine tune" U150 via the AFC line. Tuning of the reference oscillator is needed to synchronize frequencies with the cellular base station, therefore, the signal received from the base will be used to determine the correct reference frequency.

The output of U150 is split into two signals. RF_19.44MHz is used for the RF frequency reference. Output 19.44MHz is amplified by Q152 and then sent to the logic section for logic clock synchronization.

TDMA T2290/T2297: Reference Oscillator (U150)

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VOLTAGE SUPPLIES →

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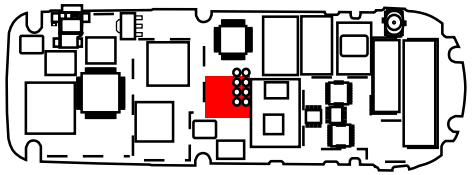
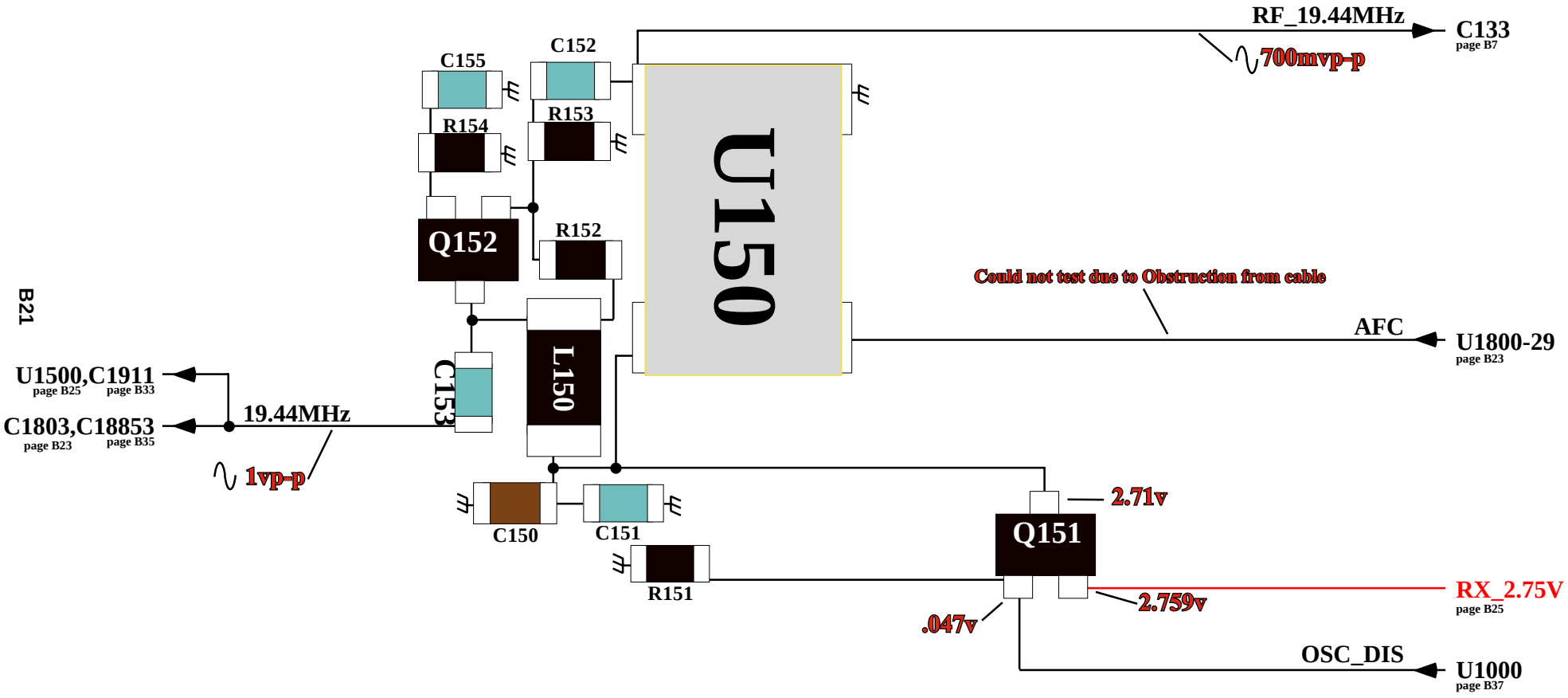




TDMA T2290/T2297: DCI (U1800)

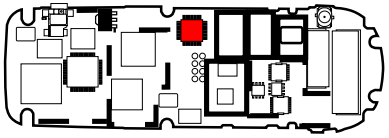
BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B23

Description

The DCI (U1800) is data converter interface between the DSP and the RF functions of a dual band TDMA transceiver. It incorporates the following functions:

- Dual channel forward data I and Q(RX_I & RX_Q)
- Two DACs for reverse data I and Q(TX_I & tx_Q)
- DAC for AFC
- DAC for AGC & DAC for reverse PA control
- DAC for PA bias
- Serial Synchronous Interface(SSI)
- Serial Peripheral Interface(SPI)
- Internally generates clocks from single master input
- Analog wide band forward data signalling functio ns with SPI interface
- Analog modulator interface
- Analog discriminator interfaces
- RF Discontinuous Receive du ring Manchester decoding
- On chip voltage reference for transmit I and Q

TDMA T2290/T2297: DCI(U1800)



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Power Step	0-5	6-10
D		

U1907-60 page B35 — TX_ENB (G)
U110 page B7 — ZIFSYN_REF 0.67V
450mVpp
U110 page B7 — RX_I
U110 page B7 — RF_DET
CR504 page B19
U110 page B7 — RX_Q
U110 page B7 — DEMOD 1Vpp
U110 page B7 — AFC
U150 page B21 — AOC_CNTL
R342 page B13 — AGC_RSSI
U110 page B7
(A)

C132 R1810 R1806 R1811 R1801 C1802 R1800 C1800

Channel: 333
Cellular TX Freq: 834.99MHz
PCS TX Freq: 1859.97MHz
Cellular RX Input Freq: 879.99MHz
PCS RX Input Freq: 1940.01MHz
RX Input: -20dBm
TX Power Level 2
TX SIGNAL
RX SIGNAL
VOLTAGE SUPPLIES
Colored boxes represent the area in which the components are placed.

2.88V
REF_2.75V page B25 — U301 page B13
TX_IX 450mVpp
U301 page B13 — TX_I
C306 page B11 — FM 1.4Vpp@10kHz

R10013 C1801 Q1802

2.89V
TX_2.75 page B25
U10-14 page B5 — FE_EN (B)
U1800-18
U1800-16 — BATT_SAV 0V
U1900 page B33 — INTEG_EN 2.08V

R1830 Q1803

RX Input	-20	-80	-116
(A)	2.36V	1.43V	.39V

U1800

24 23 22 21 20 19 18 17 16 15 14 13
25 26 27 28 29 30 31 32 33 34 35 36
12 11 10 9 8 7 6 5 4 3 2 1
37 38 39 40 41 42 43 44 45 46 47 48

RBIAS
VREBUF

C1804 C1805 R1804 C1506

TX	On	Off
(C)	.11V	2.82V
(G)	0.1V	2.82V

RX Input	<-51dBm	>-39dBm
(F)	1.81V	2.83V

2.82V
450mVpp
2.78V

C1803 R1820

(E)	Analog	Digital
	2.95V	.11V

RX	On	Off
(B)	.03V	2.81V

0.6Vpp
19.44MHz

VOLTAGE SUPPLIES
Colored boxes represent the area in which the components are placed.

QMOD_KEY (C) — U301,Q1500 page B13 page B25
FE_EN (B) — U10-14 page B5
TX_STEP (D) — U301,Q503 page B13 page B19
BATT_SAV — U110 page B7
A_D (E) — U301,Q811 page B13 page B15
LOAD_SWITCH — Q505 page B19, Q820 page B19
SS1 — U1000 page B37
CLK — U1000 page B37
MOSI — U1000 page B37
MISO — U1000 page B37
IRQ — U1000 page B37
TX_DATA — U1900 page B33
RX_DATA — U1900 page B33
C153 page B21
RX_2.75V page B25
FS — U1900 page B33
SCLK — U1900 page B33
RESET — U1000 page B37
AGC_STEP (F) — U110 page B7
2.75V page B25
TX_Q — U301 page B13
TX_QX — U301 page B13

B23

TDMA T2290/T2297: GCAP2 (U1500)

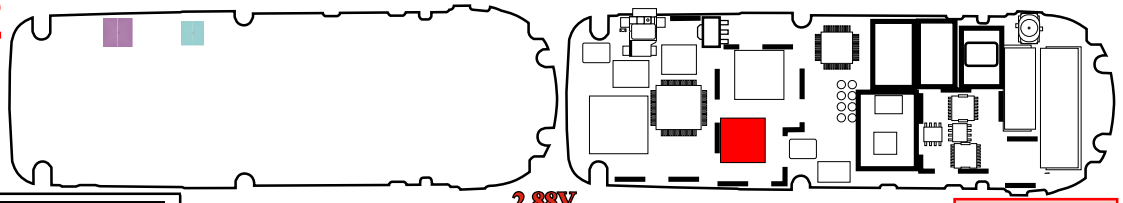
BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B25

Description

The GCAP2(U1500) provides the regulators and start-up functions for the entire radio. The GCAP2 contains the following hardware blocks:

- On/Off control signals to properly activate the radio.
- Bandgap reference voltage
- Audio amplification for the speaker
- Audio amplification for the alert
- Audio amplification for the EXT speaker
- Audio amplification of the microphone
- Audio CODEC
- 8 channel, 8 bit A/D
- Linear regulators
  - RX_2.75V for RX circuits
  - 2.75V for logic circuits
  - TX_2.75V for TX circuits
  - 5V for negative regulator
  - REF_2.75V for negative regulator reference

TDMA T2290/T2297: GCAP2



U960-6 page B29 — PWRON
U110 page B7 — AGC_RSSI
U1000 page B37 — RESET
U1000 page B37 — 3WB_RTN
U1000 page B37 — CMP_LVL
U1000 page B37 — MAN_LVL
R1011 page B41
SRAM_VCC — RAM_CS0
U1000 page B37 — SRAM_S1*
U1300 page B39 — GCAP2_INT
U1000 page B37 — 19.44MHZ
C153 page B21
VDOUB
U1000 page B37 — 32kHz
5V — 5.00V
RX_2.75V — 2.78V
U1000 page B37 — WDI
R10100 page B43 — KEY_ON*_OFF
TP29 page B44 — ON2* 4.03V
TP29 page B44 — AUDIO_OUT
B25

650mv-pp@1K
RT1
Y1500
.46Vpp
R1012
R1513
R1130
C1502
C1503
1.28V

U1900 page B33 — CODEC_BUS
U1000 page B37 — SPI_BUS
C18908 page B41 — AUDIO_IN
1.17V
THERM_AD
TX_2.75 — 2.84V
VAG — 1.39V
2.5V
C1507
R1514
R1597
R1133
R1132
CR1563
1.45V
4V
C18912
C18862

U1500
GCAP2
PA_SENSE
LI_CELL
PA_DRV
SPKR_IN
SPKROUT
CD_CAP
AD4
CONV_BYP
AUX_OUT
MIC_OUT

2.88V
REF_2.75V
ALRT_OUT — R1555 page B31
QMOD_KEY — U1800-20 page B23
2.89V — TX_2.75
SW_QMOD_KEY
4.46V — B+ page B29
SPKR+ — R10095 page B31
SPKR- — R10096 page B31
HDST_SPKR — R1536 2.8V page B31
3.43V — DRIVER_B+
3.53V
2.8V — 2.75V
1.45V — AUX_MIC — J940-1 page B31
1.57V
1.39V — VAG
2.33V — MIC_BIAS
1.64V — MIC+ — J900-1 page B31
.733V — MIC- — J900-2 page B31

Q1501
C1509
C1563
L907
L1593
L967
L1599
L1550
C1551
C1597
C1594
C1542
R1554
R1553
R1537
C1516
C1595
R1524
R1515
R1522
R1516
R1521
R1580
C1580
C1581
C1515
C1511
C1512
R1532
C1513
C1510
C1521
C1523
C1522
C1514
C1536
C1539
C1538
C1537
C1541
C1540
C1544
C1545

	TX ON	TX OFF
A	.113V	2.82V
B	2.87V	0V

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VOLTAGE SUPPLIES
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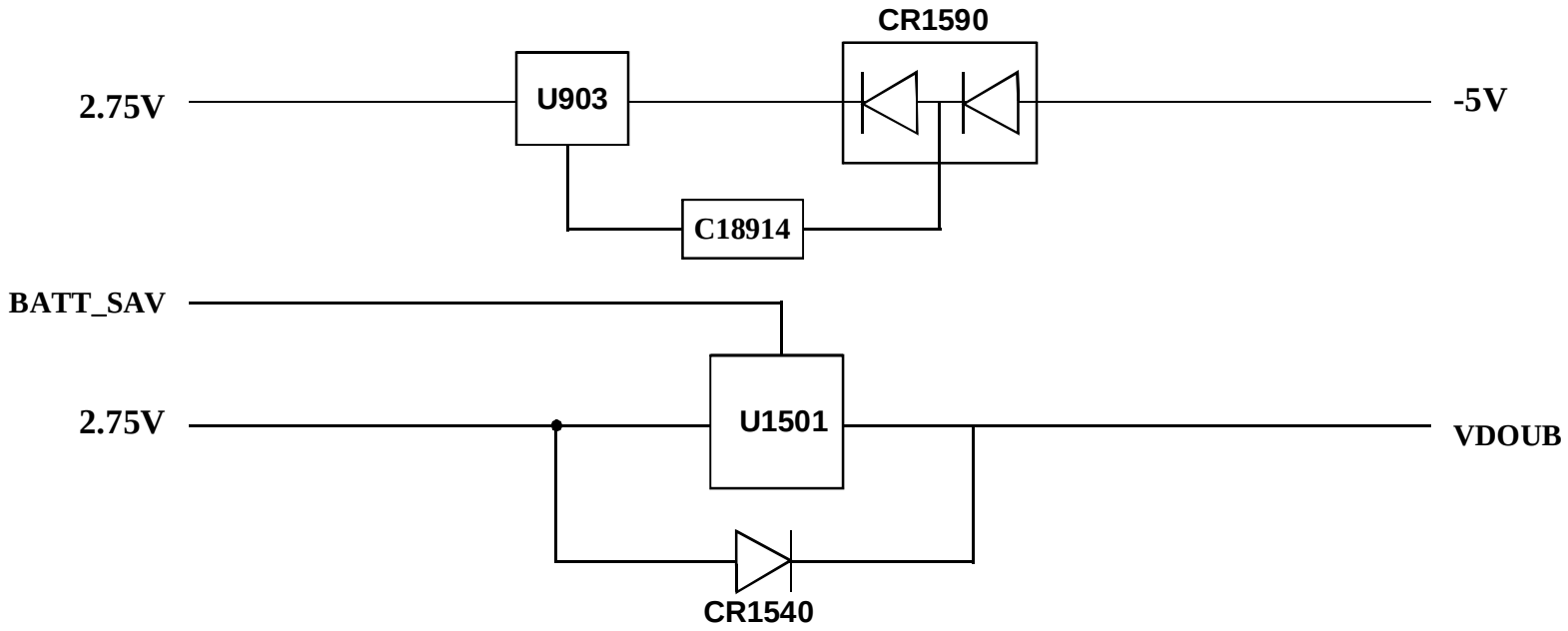
TDMA T2290/T2297: Voltage Regulators



Description

There are some circuits that require a voltage higher than the battery source. For this reason, a voltage doubling charge pump circuit is provided. U1501 takes the 2.75V source and oscillates it with a high peak to peak signal. The positive region of the signal is then sent out to produced the VDOUB supply.

BATT_SAV is used to cut off the VDOUB supply to conserve battery power. When the BATT_SAV line is on (high), U1501 will be disabled.

U903 is the negative supply generator. It is used to supply -5V to the LCD display contrast circuitry.

U903 generates a negative voltage by generating a 3 Vpp square wave from the 2.75V source. The signal is then rectified to generate a -3V supply. This supply is not at a sufficient level for proper operation of the LCD display. In order to increase the negative voltage a sample of a square wave that U903 produces is combined with the -3V output of U903. This process will change the voltage reference of the square wave to -3V instead of 0V. The square wave is now reaching a negative peak value of -5.4V. The square wave is then rectified by CR1590, allowing a -5V volt supply to be generated.

TDMA T2290/T2297: Voltage Regulators

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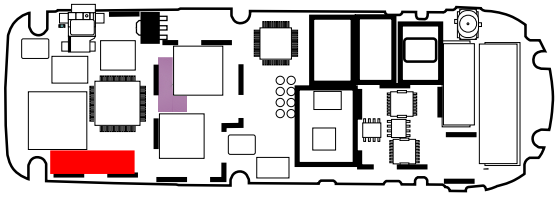
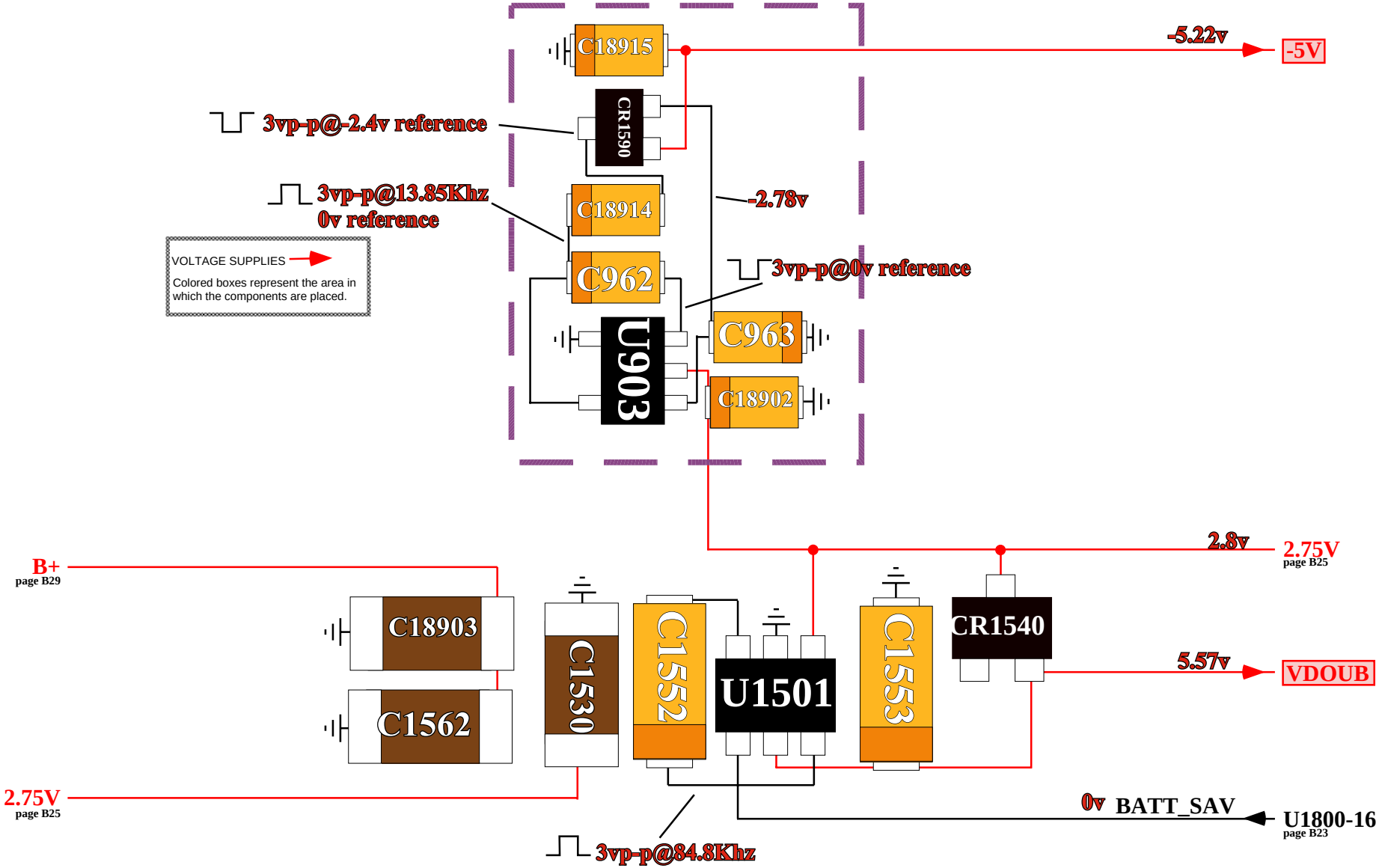
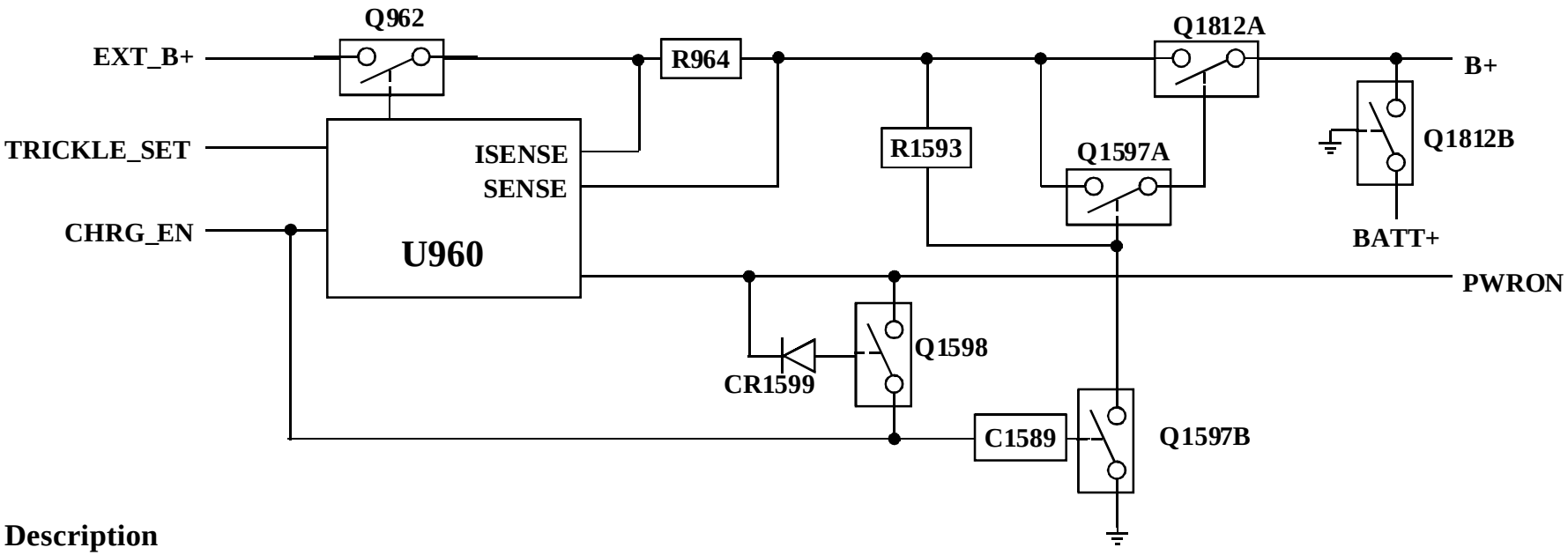




TDMA T2290/T2297: Charger



B28

Description

U960 is a Charger control OverVoltage IC(COVIC). It is used to control the rate of charge to Nickel Metal Hydrid(NiMH) batteries that are installed in the transceiver. U960 is also used to control any excessively high voltage conditions that can damage the transceiver.

EXT_B+ is the external supply from an accessory that is being used to allow the batteries to get charged. Q962 controls the rate of charge and is the disconnecting device to the internal circuit of the phone if a high voltage(overvoltage) condition exists. U960 controls the rate of charge through Q962.

Three charging rates existsl;(1) trickel, (2) maintenance, and (3) full. Trickel and maintenance charging is controlled by the STUART(U1907) via the TRICKEL_SET line. Full rate charging is controlled by the STUART(U1907) via the CHRG_EN line. The time period of charging the batteries is determined by monitoring the battery voltage. The battery level is monitored in three categories; (1) 1/3 charge, (2) 1/2 charge, and (3) 3/4 charge. Each catergory will determine the time period of charge.

Once the charging rate has been determined, the batteries will be charged through Q1812B. Q1812B also helps in preventing reverse battery conditions.

If an over-voltage condition exists, Q962 needs to be completely turned off to protect the circuitry of the phone. The SENSE line in the U960 is used to determine whether there is a over-voltage condition. If an overvoltage condition exists, the TRICKLE_SET and CHRG_EN ports in the U960 will be disabled. Having these two ports disabled will not allow Q962 to be driven on.

The SENSE line is also used to detect a charging accessory. When a charging accessory is detected the PWRON line is pulled high. This will inform the GCAP(U1500) that an external source is attached to the phone.

Having the PWRON high will also switch Q1598 on and allow the voltage to rise across C1589. C1589 will then discharge into the base of Q1597B. Q1597B will be switched on during the discharge cycle of C1597. Switching Q1597B on will lower the base voltage of Q1597A and switch Q1597A on. Having Q1597A on will pull the gate of Q1812A high , switching Q1812A into an off state. Q1812A will remain off until C1589 is discharged. This circuit design is used to prolong the accessory source connection to the B+ line, giving U960 enough time to react to an overvoltage condition.

TDMA T2290/T2297: Charger

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VOLTAGE SUPPLIES →

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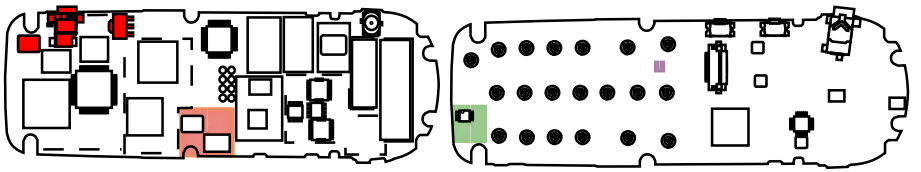


EXT_B+ 4.53v

EXT_B+

EXT_B+ 4.53v

R1011 page B41 ← MANUAL_TEST 2.86v

C1573

J1

3 1 4 2

J605

C1574

CR1562 4.47v

B

Q962

4.53v 3.78v

R964 3.97v 4.04v

C

B29

.564v

Q1597

.38v

C1589 2.64v

.563v

R1593

4.53v EXT_B+

U1907-51 page B35 ← TRICKEL_SET

U960

R1594 R1598 CR1599 CR1598 CR1597 Q1598 R1596

C1590

J604

4v

VR960

Q1812

B+

BATT+

C1592

R1592

C829

4v BATT+

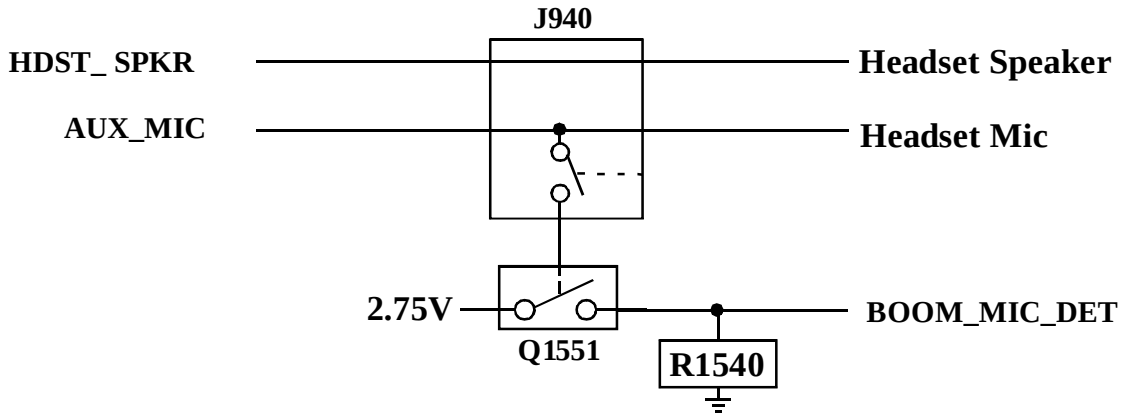
Charger	On	Off
A	2.68V	.11V
B	4.47V	0V
C	3.79V	0V

U1907-50 page B35 ← CHRG_EN (A)

U1500 page B25 ← PWRON (D)

Supply	External	Battery
D	3.44V	0V

TDMA T2290/T2297: Audio Circuit



B30

Description

When a headset is in serted in J940, the internal speaker and microphone is dis abled. The user can now use the headset for handsfree conversation. BOOM_MIC_DET informs U1000 whethe r a headset is inse rted or not. The state of BOOM_MIC_DET is controlled by Q1551.

When the headset is inserted the biasing voltage for the AUX_MIC will no longer be pr esent at the base of the NPN transistor Q1551. This will switch Q1551 on, thus, allowing BOOM_MIC_DE T to be pulled high by source 2.75V. When the headset is not inserted, the AUX_MIC biasing voltage is present at the base of Q1551. This condition will switch Q1551 off, thus, pulling the BOOM_MIC_DET to ground through R1540.

There are two distinct audio paths for the microphone. One is for the auxilia ry microphone(headset mic) and the other is for the internal microphone. This is not the case with the speaker audio paths. The headset speaker and the int ernal speaker share the same audio path which comes from the GCAP(U1500). In order to disable the inter- nal speaker when the headset is attached, the phase of the audio signal on the SPKR- line is phase shifted by 180 º. When the internal speaker is enabled the SPKR+ and SPKR- have the same audio signal e xcept that SPKR- is phase shifted 180º. When a headset is attached, the SPKR- is not phase shifted 180º. The SPKR+ and SPKR- have the same audio signal and are in phase. This condition will no t allow the internal s peaker to function, thus, disabling the inte rnal speaker.

TDMA T2290/T2297: Audio Circuit

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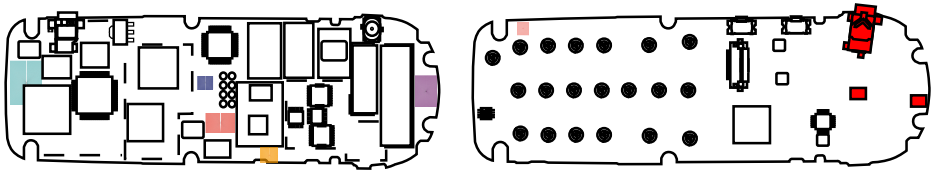

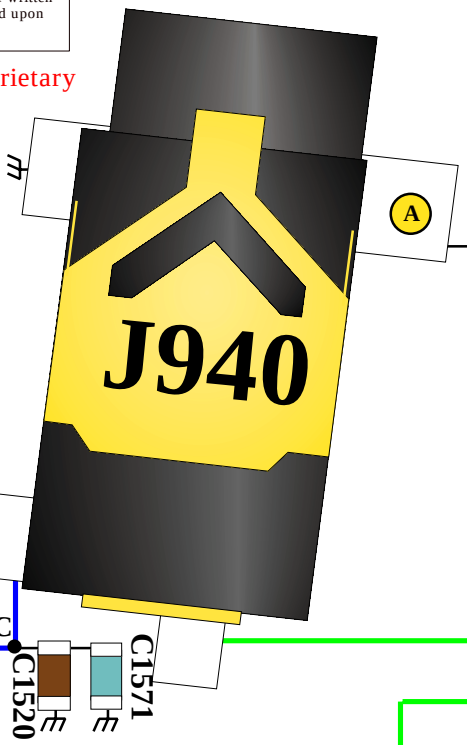

Headset	On	Off
A	0v	2.78v
B	2.78v	0v

B31

C18858
R1540
B
BOOM_MIC_DET
U1000
page B37
Q1551
2.71v
2.75V
page B25
VR1551
1.45v HDST_SPKR
L1593
page B25
C1518
1.45V
SPKR+
L907
page B25
VR501
R10095
1.45v
C1519
R1536
C1572
C18900
L1594
page B25
AUX_MIC
C1520
C1571
1vp-p max
1mvp-p min
VR502
U1500
page B25
ALERT_OUT
4vp-p
R1555
R10096
C18901
AL600
page B45
ALERT-
C1583
C18850
C1582
C1550
VR1500
SPKR-
L967
page B25
J900
AL600
page B45
ALERT+
MIC+
C1515
page B25
B+
page B29
3.7v
R1581
R1523
2.33v
MIC_BIAS
page B25
.75v
MIC-
C1581
page B25
1.63v
J942
J941

VOLTAGE SUPPLIES →

Colored boxes represent the area in which the components are placed.

TDMA T2290/T2297: DSP (U1900)

BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B33

Description

The following list is a description of the DSP(U1900):

- ROM Mask Device(48K)
- Patch RAM space(16K)
- Fixed point MAC(multiply accumulator)
- 8-bit parallel interface
- 8-bit control I/O interface
- Dual serial I/O ports
- Two external interrupts
- Flexible power management including Sleep mode, Sleep with slow internal clock, and stop
- **Three modes of operation**
  1. Actively running
  2. Light sleep - Clocks running, but lower power consumption
  3. Deep sleep - All clocks off, extremely low power consumption
- **Digital Traffic Channel**
  1. Acquiring and maintaining synchronization with the Digital Channel
  2. AFC, AGC, AOC control loops
  3. Vocoders (ACELP)
  4. Channel equalization
  5. Channel decoding
  6. Channel encoding
  7. Audio functions
  8. MAHO measurements
- **Digital Control channel**
  1. Essentially DTC minus audio and vocoders
  2. ROCM instead of MAHO
  3. Modem goes into deep sleep for long periods
- **Analog Control Channel**
  1. No RX functions - modem in deep sleep
  2. Manchester Encoder
  3. Transmitter control
- **Analog voice channel**
  1. Audio processing
  2. SAT detection/Transponding

TDMA T2290/T2297: DSP(U1900)

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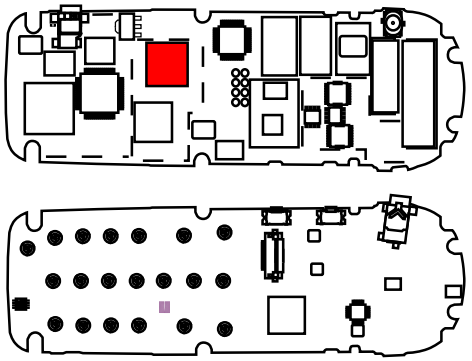
VOLTAGE SUPPLIES →

Colored boxes represent the area in which the components are placed.



U1000 page B37 — DSP_RST — 2.77v — R1913 — R1901

2.75V page B25 — 2.78v

C9910 — R1910 — R1911 — R1912 — C1911 — C1902 — 4.2vp-p

2.75V page B25 — 2.78v — C153 page B21 — 19.44MHZ — 1.6vp-p

B33

Q1802 page B23 — INTEG_EN

U1903-27 page B35 — GP_INT

U1000 page B37 — DSP_TRAP

U1800-2 page B23 — TX_DATA

U1800-1 page B23 — RX_DATA

U1800-47 page B23 — SCLK

U1800,U1907 page B23 page B35 — FS

U1907-28 page B35 — RWN

U1907-29 page B35 — IO

CK12

U1900

VDDA — R1900 — C1906 — 2.78v — 2.75V page B25

C1900 — C1903 — C1904

C1910 — VPP — R10117 — 2.78v — 2.75V page B25

C1905

U1907 page B35 — MODEM_DATA

U1500 page B25 — CODEC_BUS

U1907 page B35 — MODEM_ADDR

TDMA T2290/T2297: STUART (U1903)

BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B35

Description

The STUART IC(U1903) is a custom gate array that uses the following functions:

Host Port Emulation - This provides a bus interconnection between the call processor and the DSP via the call processor's parallel memory bus, interconnected to the modem DSP's parallel memory bus. This communications port is functionally identical to the host port provided for the Motorola DSP; To both devices, the port appears as a bus-mapped peripheral. The call processor sees the port as an 8-address block in memory at a location determined by the call processor's programming of its own chip select for the START IC. The DSP sees the port as an 8-address block in I/O space. Because the STUART IC uses the high byte of the DSP's bus, provisions are made for byte/word conversion, to be compatible with the existing word-wide communications with U1000(Call processor).

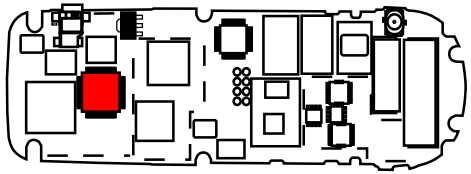
DSP Timer - It provides a timer function. This is a device, accessible to the DSP, which implement a continuously clocked timer, with rollover, a feature needed for modem functionality but difficult to implement with the Lucent device. The Lucent timer can be set up to either stop on count=0, or to repeat the last count interval. We need a counter that can be set up to interrupt at a particular point in time, and then keeps counting, so that real-time is preserved, and can be set for a future time interval. This timer has a clock that is coherent with the symbol rate.

General Purpose I/O - It provides a 4-bit general purpose I/O port, with programming data direction function, as an extension to the call processor bit I/O set.

RF SPI interface - Improved interface between the Call processor, DSP, and ZIFSYN for scanning requirements needed because of the PCS band

Transmitter control logic - Transmitter keying and frequency band selection.

TDMA T2290/T2297: STUART(U1907)



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C153 page B21 — 19.44MHZ 1.1vp-p — C18853

U1000 page B37 — CALL_DATA 4.8vp-p

U1000 page B37 — CALL_ADD 4.6vp-p

U1000 page B37 — RWB 3.6vp-p

U1000 page B37 — ECLK 3.8vp-p

3.8vp-p — R1700 — 2.79v

U1000 page B37 — HOST_EN

U1000 page B37 — RESET 2.82v

2.82v

2.75V page B25

U1900 page B33 — GP_INT 3vp-p

U1900 page B33 — RWN 2.8v

U1900 page B33 — IO 2.8v

3vp-p

U1900 page B33 — MODEM_ADDR

U1900 page B33 — MODEM_DATA 3vp-p

2.82v

2.75V page B25

1900TX	On	Off
Pin 61		.055v

800TX	On	Off
Pin 62		.055v

	800Mhz	1.9Ghz
Pin 63	2.82v	.055v
Pin 64	.052v	2.82v

C1531 — R1036 — 2.82v — 2.75V page B25

800*_1900 — Q351 page B11

800*_1900 — U10,U301 page B5 page B13

800_1900* — U104 page BXX

800KEY* — Q1805 page B15

1900KEY* — Q1804 page B15

A TX_ENB — U1800 page B23

RDB — U1200 page B39

ZIFSYN_EN — U110 page B7

RF_DATA — U110 page B7

RF_CLK — U110 page B7

IRQ — U1000 page B37

B ACC_STATE — R1099 page B41

TRICKLE_SET — U960-3 page B29

C CHRG_EN — U960-3 page B29

4.4vp-p FS — U1900 page B33

C1700 — C18911 — C18910 — C1701 — C1702

U1907 STUART

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
	49	50 2.78v	51	52	53 2.82v	54 2.2vp-p	55 4vp-p	56 3.2vp-p	57 3vp-p	58 4.5vp-p	59	60 .222v	61	62	63	64

TX	On	Off
A	0.1V	2.82V

Charger	On	Off
C	2.68V	.11V

Accessory	CLA	AC Chrgr	DHFA
B			

VOLTAGE SUPPLIES →

Colored boxes represent the area in which the components are placed.

B35

TDMA T2290/T2297: Call Processor (U1000)

BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B37

Description

U1000 is a single-chip microcontroller that controls major functions of the cellular phone. U1000 will perform the functions of both the master controller and keyboard processor. These functions include:

- Keypad interrupt and scanning
- Display driving
- Control of audio and RF hardware
- Call processing (signalli ng) software
  - ON/OFF control
  - EEPROM access
  - Synthesizer programming
  - Automatic Frequency Control(AFC)
  - Transmit power setting
- User Interface

U1000 is not packaged with internal memories as past Call processors. This means that vital information that was previously stored in the memory of previous call processors is now stored in the external EEPROM(U1908).

TDMA T2290/T2297: Call Processor(U1000)

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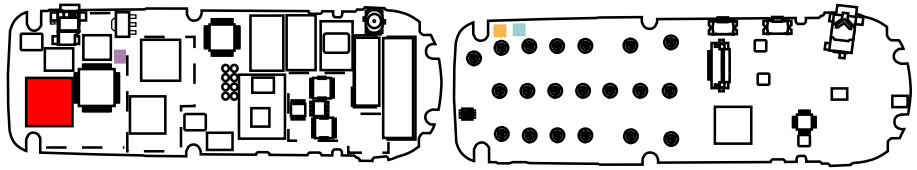
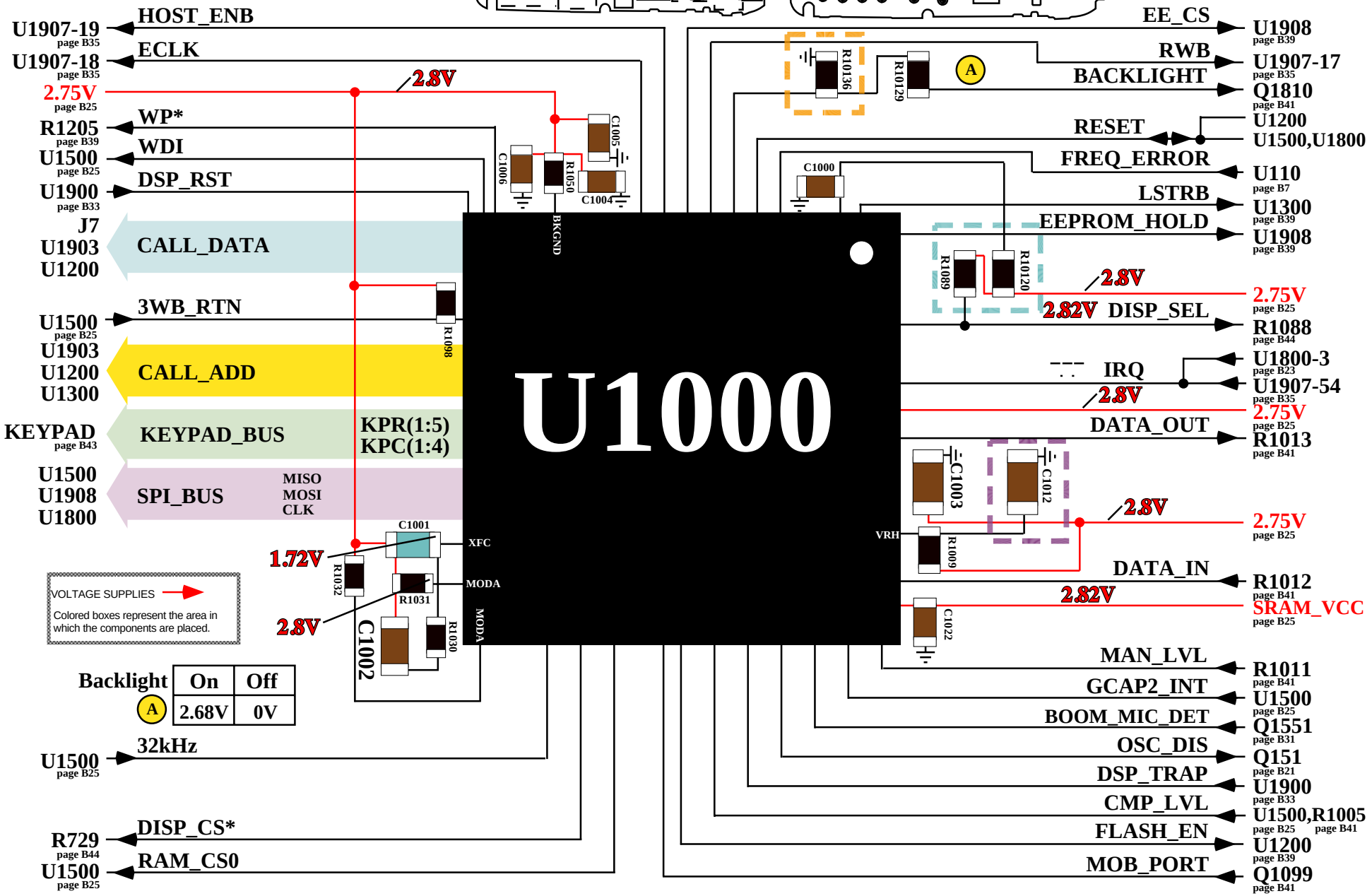
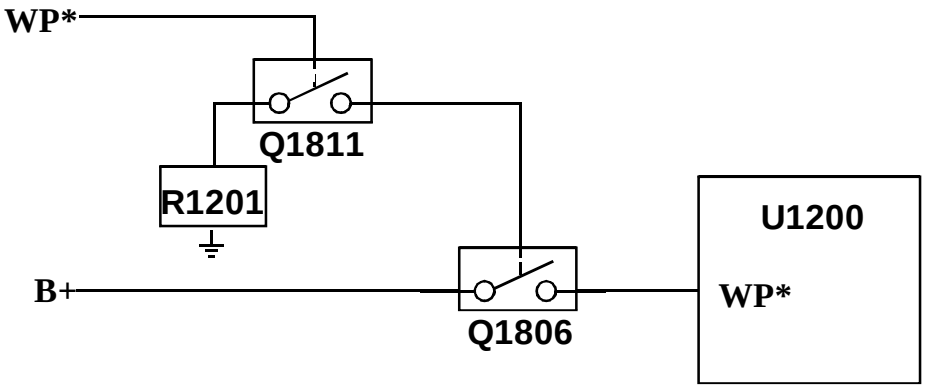




TDMA T2290/T2297: Memory



Description

A serial EEPROM(U1908) of 256K bytes is used for storage of the NAM information, authentication keys, phasing data, ESN, and memory. The EEPROM serial interface to the microcontroller is a standard SPI-compatible interface.

U1300 is a 64K x 16 low voltage, low power SRAM. U1300 uses a parallel interface bus.

U1200 is a 512K x 16 flash EPROM. U1200 uses a parallel interface bus.

The WP* line is used during EPROM flash conditions. When the EPROM is not being flashed, WP* is at a low state. This condition will switch Q1811 off, thus, allowing the gate of Q1806 to be pulled high. A high state at the gate of Q1806 will switch Q1806 off, thus, not allowing WP* from U1200 to be pulled high by B+.

During flashing conditions, WP* is pulled high. This condition will switch Q1811 on, allowing the voltage at the gate of Q1806 to drop. A lower voltage at the gate of Q1806 will switch the transistor on. This condition will allow WP* from U1200 to be pulled high by B+.

TDMA T2290/T2297: Memory

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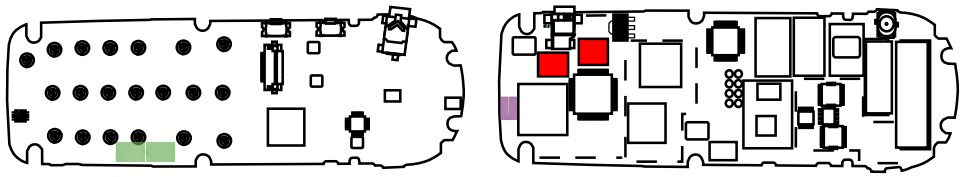
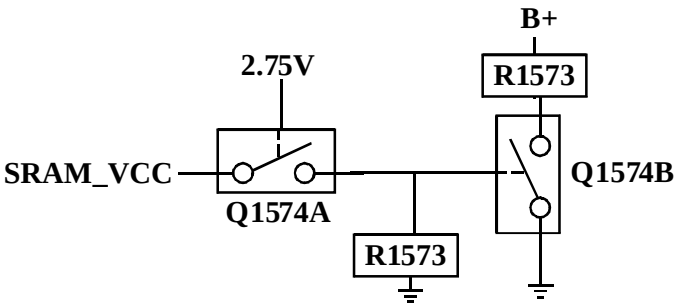


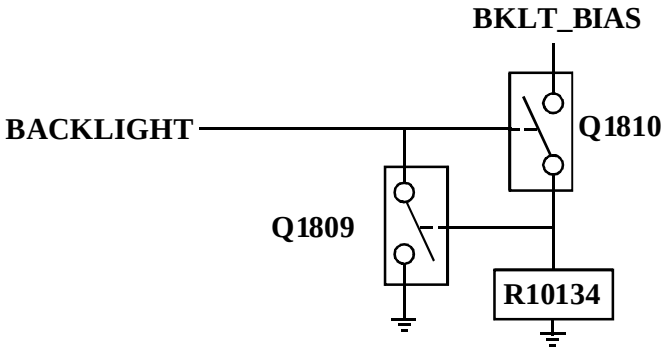
VOLTAGE SUPPLIES →

Colored boxes represent the area in which the components are placed.

U1000 page B37 CALL_DATA
U1000 page B37 CALL_ADD
U1000 page B37 FLASH_ENB
2.82v
U1500 page B25 SRAM_S1*
U1000 page B37 LSTRB
2.75V page B25
2.82v
C1023
U1300
R1090
R1092
U1200
WP*
2.8v
2.75V page B25
C1200
C1093
2.78v
SRAM_VCC page B25
C1021
RDB
U1907-58 page B35
.01V
RESET
U1000 page B37
CALL_DATA
U1000 page B37
CALL_ADD
U1000 page B37
U1908
U1000 page B37 SPI_BUS
U1000 page B37 EE_CS
U1000 page B37 EEPROM_HOLD
2.75V page B25
.037v
R1201
R1203
R1204
R1205
R1200
Q1806
Q1811
4.48v
4.48v
B+ page B29
.037v
WP*
U1000 page B37
B+ page B29
4.48v

TDMA T2290/T2297: B+ Discharge/Backlight Driver





B40

Description

The B+ discharge circuit consists of Q1574 and it's related components. This circuit is used in conjuncti on with the Power Cut process.

The Power Cut process will initiate an automatic power up cycle if battery power is disrupted for less than 3 seconds. During a Power Cut transistion, the phone will power up automatically without activating the wake-up tone. Also, the phone will wake up to the same state that is had prior to the power disruption. The customer will never realize that a power disruption occurred. If power is disrupted and not re-covered within 3 seconds, the phone will remain off.

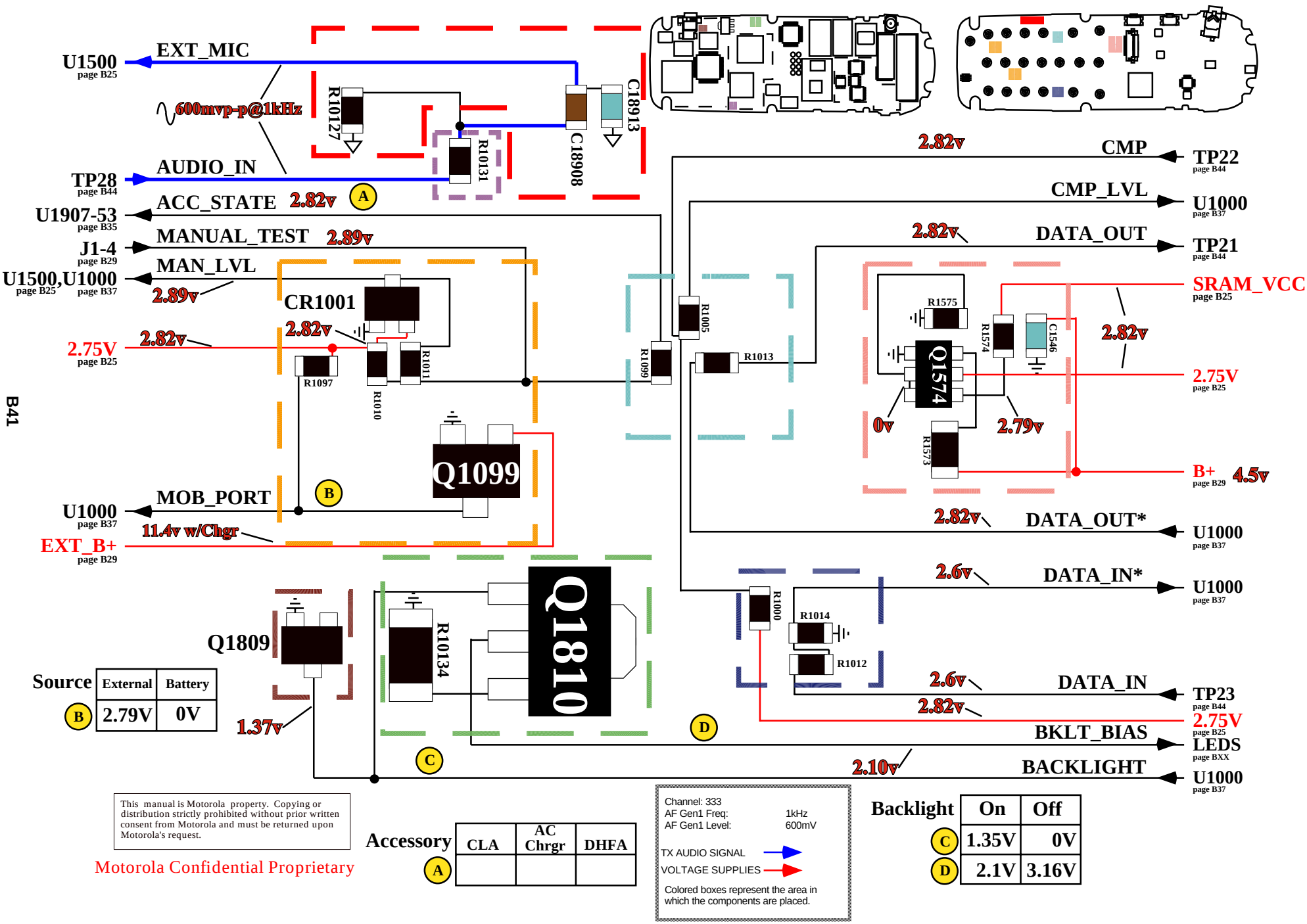
Capacitor C1563(GCAP section, page B25) is used to maintain the SRAM_VCC supply active when a power disruption occurs. SRAM_VCC is the supply voltage to maintain the RAM(U1300) active during a power disruption. During a power disruption everything except SRAM_VCC, will be powered off. In this condtion the supply 2.75V is off. This will allow Q1574A to be switched on, allowing the gate of Q1574B to be pulled high by the source SRAM_VCC. Q1574B will be turned on when a high state is present at the gate. This will then ground R1573 and allow the B+ line to discharge through R1573. The process of discharging the B+ line helps in eliminati ng any parasitical voltages on the B+ line when the power is re-covered prior to the 3 second time out.

When the phone is powered on, 2.75V will be present. This will switched Q1574A off and allow the gate of Q1574B to be pulled low by R1573. A low state at the gate of Q1574B will turn it off and not allow R1573 to be grounded.

The BACKLIGHT line is used to activate the keypad backlights. A high state at BACKLIGHT will activate Q1810 and complete the backlight circuit path to ground. The LEDs will then turn on. Q1809 is used as an overvoltage protection. If the voltage at the base of Q1809 is high than the voltage at the base of Q1810, Q1809 will be switched on. This will force the BACKLIGHT line to ground and disable Q1810. The backlight circuit path will no longer have its path to ground and the backlights won't activate.

The ACC_STATE line is used to indicate what type of accessory is attached to the phone. The accessory will place a specific load on the MANUEL_TEST line that is unique to other types of accessories.

TDMA T2290/T2297: B+ Discharge/Backlight Driver



Source	External	Battery
B	2.79V	0V

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Accessory	CLA	AC Chrgr	DHFA
A			

Channel: 333
AF Gen1 Freq: 1kHz
AF Gen1 Level: 600mV

TX AUDIO SIGNAL

VOLTAGE SUPPLIES

Colored boxes represent the area in which the components are placed.

Backlight	On	Off
C	1.35V	0V
D	2.1V	3.16V

TDMA T2290/T2297: Keypad

BLOCK DIAGRAM NOT NECESSARY
REFER TO PAGE B43

Description

To cycle the power on the phone, the power key needs to be depressed. Upon depressing the power key, KEY_ON*_OFF will be pulled low. As soon as the power key is released the KEY_ON*_OFF line will be pulled high. The GCAP(U1500) will then recognize this transistion and cycle the power to the phone. A power cycle can also be done externally using TP29. TP29 is a mupliplexed line used for power cycling and an audio output line. CR730 isolates the power cycle function to the KEY_ON*_OFF line.

U1000 will scan the row(KPR1:KPR6) and column(KPC1:KPC4) matrix to determine if a key is being depressed. One key press will have a row and column combination that U1000 uses to distinguish each key.

TDMA T2290/T2297: KEYPAD

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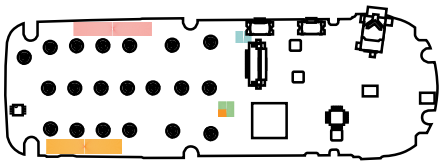

Colored boxes represent the area in which the components are placed.

U1000 page B37 KPR(1)
U1000 page B37 KPR(2)
U1000 page B37 KPR(3)
U1000 page B37 KPR(4)
U1000 page B37 KEY_ON*_OFF
U1500 page B35

R10100 R10105 R10104 R10103 R10102

C18885 R10108 R10107 C112 R10106

KPC(2) U1000 page B37
KPC(1) U1000 page B37
KPR(5) U1000 page B37

END SND STORE FCN RCL CLEAR

1 2 ABC 3 DEF
4 GHI 5 JKL 6 MNO
7 PQRS 8 TUV 9 WXYZ
* 0 OPR #

R10101
KPR(6) U1000 page B37

R730 KEY_ON*_OFF U1500 page B25
AUDIO_OUT TP29 page B44
CR730

C18886 R10109
U1000 page B37 KPC(3)

R10110 C18887
KPC(4) U1000 page B37

TDMA T2290/T2297: Connectors

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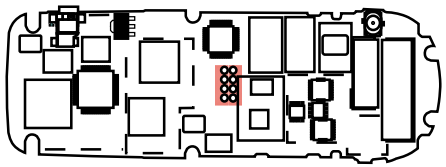
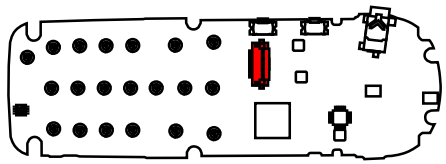




VOLTAGE SUPPLIES →

Colored boxes represent the area in which the components are placed.

B44

B+ TP25 TP961 GND

SCI_RXD TP23 TP29 ON*/AUDOUT

MANUAL_TEST TP20 TP21 SCI_TXD

AUDIN TP28 TP22 CMP

J902

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

R712

R1088

C711

R729 R735 R734 R728 R727 R726 R725 R724 R723 R722 R721

RESET → U1000 page B37

DISP_CS* → U1000 page B37

CA0 → U1000 page B37

RWB → U1000 page B37

CD8 → U1000 page B37

CD9 → U1000 page B37

CD10 → U1000 page B37

CD11 → U1000 page B37

CD12 → U1000 page B37

CD13 → U1000 page B37

CD14 → U1000 page B37

CD15 → U1000 page B37

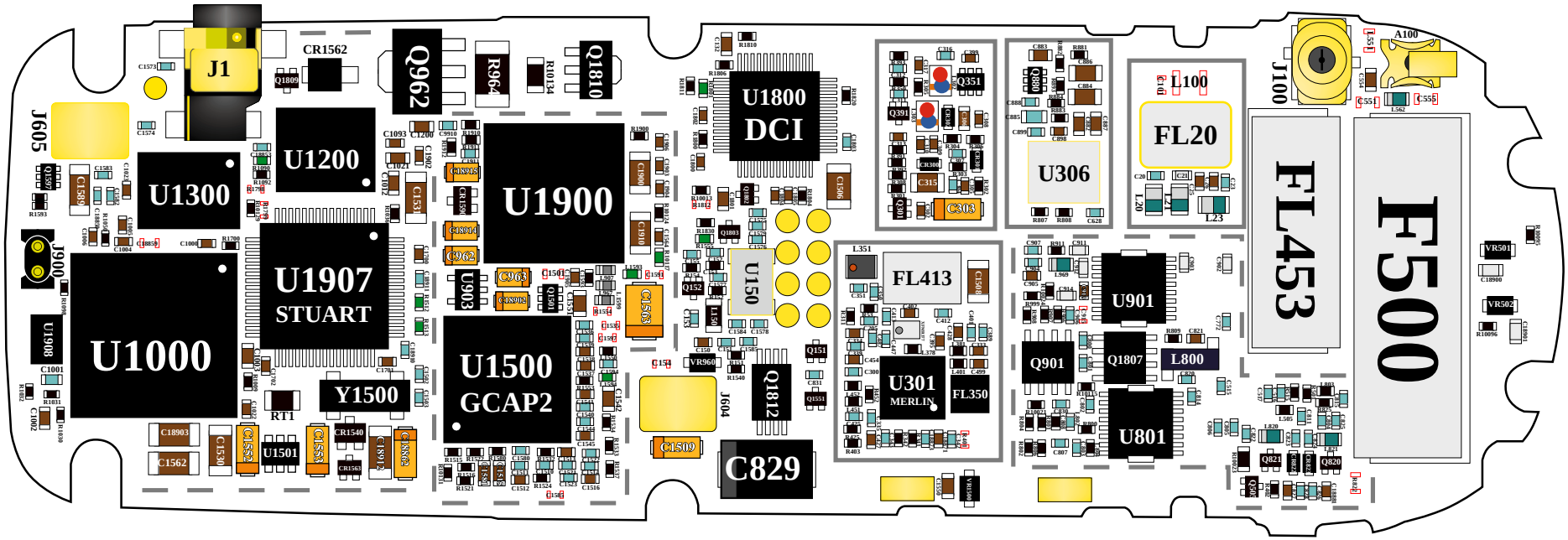
DISP_SEL → U1000 page B37

-5V page B37

2.75V page B35

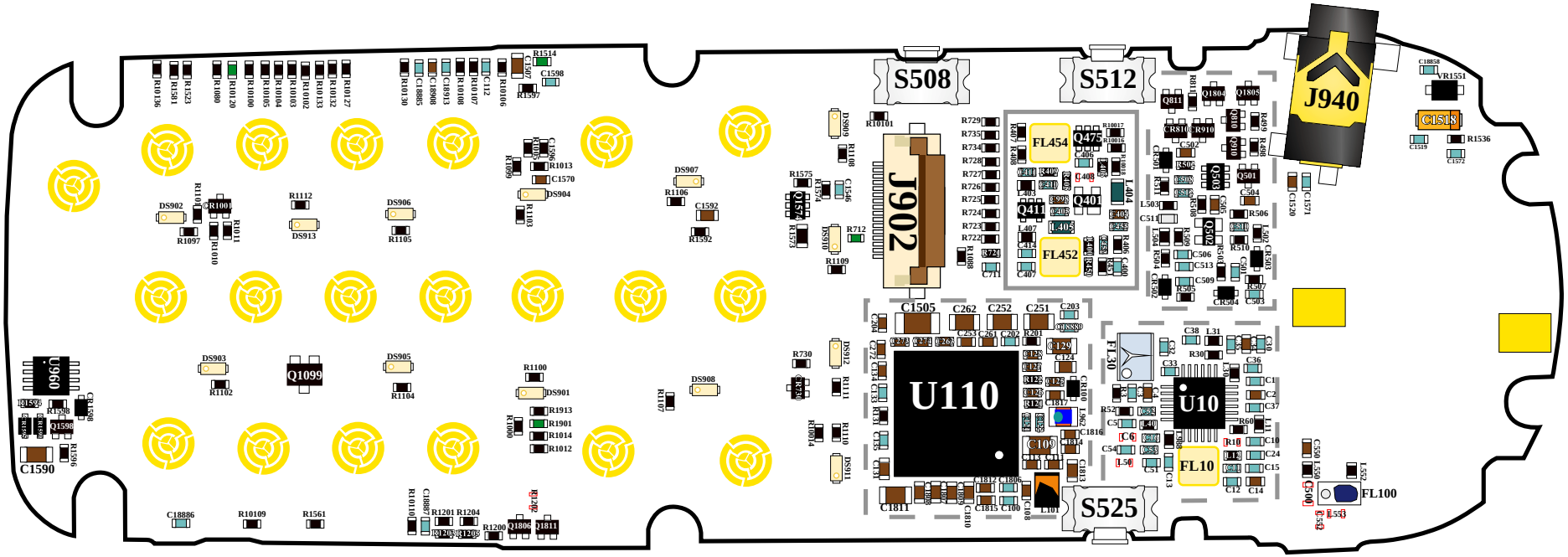
TDMA T2290/T2297: Board Layout Side 1

Board Issue: P8



B45

TDMA T2290/T2297: Layout Side 2
Board Issue: P8



Feedback Form

TDMA T2290/T2297 Feedback Form

To report any problems or omissions to this service manual;

1. Photocopy this page.

2. Fill out the lines below and give your comments.

3. Fax this form to Motorola TDMA Global Service Support
   Fax number 1-815-884-3121 Attn: Documentation Staff

Service Manual Number: _____ Revision: _____

Your Name: _____

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Nature of Problem or Omission: _____

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